

PART-B
VOLUME – IV
CIVIL


PART – B (CIVIL) (BOOK 4 OF 5)	
D – 1	CIVIL WORKS


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D-1-1				
1.00.00	GENERAL			
1.01.00	<p>This specification is to cover, survey works, site grading works, design, preparation of general arrangement drawings, construction and fabrication drawings, supply of labour & materials and construction of all civil, structural and architectural works by the Bidder.</p> <p>Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as civil works. Various buildings, structures, plant and systems, facilities, etc., covered under the scope is given in Part-A and herein.</p> <p>The work to be performed under this specification consists of design, engineering, construction, erection and providing all labour, materials, consumables, equipment, temporary works, temporary storage sheds, temporary colony for labour and staff, temporary site offices, constructional plants, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications including revisions and amendments thereto as may be required during the execution of work.</p> <p>All construction materials including cement, reinforcement steel, coarse & fine aggregate, structural steel and construction water etc., shall be arranged by the Bidder.</p> <p>The scope shall also include setting up by the Bidder a complete testing laboratory in the field to carry out all relevant tests for structural steel, reinforcement steel & reinforced concrete (RCC) works.</p> <p>Detailed geotechnical investigation in the proposed area has been carried out by the Owner and the bore-log data is furnished in Annexure ‘C’.</p> <p>The work shall be carried out according to the design/drawings to be developed by the Bidder and approved by the Employer. For all buildings, facilities, systems, structures, etc., necessary layout and details are to be developed by the Bidder keeping in view the statutory and functional requirements and providing enough space and access for operation, use and maintenance. The Bidder’s work shall cover the complete requirements as per IS codes, fire safety norms, requirements of various statutory bodies, International Standards, best prevailing practices and to the complete satisfaction of the Employer.</p> <p>The Bidder shall make the layout and levels of all structures from the general grid of the plot and the nearest GSI benchmark or other acceptable benchmark of Government department / NTPC Ltd as per the directions of the Engineer. The Bidder shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Engineer for general checking of the correctness of the civil works.</p> <p>All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to.</p> <p>The Bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site-specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.</p>			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-6401-001-2	SUB-SECTION-D-1 CIVIL WORKS	PAGE 1 OF 103


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	<p>In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Bidder without any extra cost to the Employer.</p> <p>Wherever there is an anomaly in the design concept between the data furnished in the General Design Criteria & Design Concept of Buildings, the data furnished in the design concept of buildings shall be treated as final.</p> <p>Bidder or his agencies engaged as detailer for fabrication drawings should have the experience of detailing for power plant structures or steel plant or Industrial structures like Petro/ Chemical/Refinery/Cement etc.</p>			
1.02.00	SCOPE OF WORK			
	<p>The scope of work for the contractor shall include the analysis, design, construction, erection of all civil, structural & architectural works and all other items mentioned in Part-A of this Specification.</p>			
1.02.01	Construction Facilities			
	<p>For details of construction facilities refer to Part-A of this specification.</p>			
1.02.02	Exclusions:			
	<p>The details of exclusions and terminal points refer to Part-A of this specification.</p>			
1.03.00	SUBMISSIONS			
1.03.01	<p>The drawings included in the Bidding Document provide a general idea about the work to be performed under the scope of this contract. These are preliminary drawings for bidding purposes only and are by no means the final drawings or show the full range of the work under the scope. Work has to be executed according to drawings prepared by the contractor. The following documents and drawing shall be submitted and got approved before commencement of detailed engineering. The list given below is not exhaustive but indicative only.</p> <ul style="list-style-type: none">a) Project design intent, design criteria which shall cover all design aspects, design parameters, material of construction and its specifications, structural idealization including framing system for gravity loads and lateral loads (wind and seismic), load cases, load combinations, assumptions, references, basis of analysis & design of all buildings, machine foundations, facilities, systems and structures etc.b) Survey drawings indicating spot levels for the area under the scope of work.c) Plants 'General Layout Plan' drawing with coordinates of roads, boundary wall, buildings and facilities, pipe/cable corridors, railway lines, Green Belt etc.d) Geotechnical investigation scheme, if requirede) Geotechnical Investigation report including foundation system recommendations.f) Typical design of pile, if applicable, in terms of type, rated capacity, length, diameter and the termination criteria to locate the founding level.g) Scheme for initial and routine load test of Pile foundation high strain dynamic load test and pile integrity test methodology.h) Details of corrosion protection measures for all structures, foundations etc.			
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	<div>i) Architectural concept designs which shall cover all concept plans and elevations, finishes and area statements of all buildings and facilities</div> <div>j) The following sequence of submission of drawings/ documents is to be followed:<div>- Architectural drawings, wherever applicable</div><div>- Relevant GA drawings & loading document</div><div>- Analysis & design of structures/ buildings/ facilities with drawings.</div><div>- Analysis & design of foundations with drawings.</div></div>		
1.03.02	Detailed construction drawings and design calculations for all civil works for static as well as dynamic analysis shall be submitted for approval prior to undertaking construction work.		
1.03.03	Design calculations shall be done in M.S. Office (latest version) and Drawings shall be prepared in Auto Cad (latest version). The analysis shall be done by using STAAD PRO / ANSYS/ SAP2000 (latest version). However, design may be carried out manually, using computer work sheets or by using suitable software programs, as mutually agreed by Employer. Final calculations and drawings shall be submitted as mentioned in General technical Requirements Chapter.		
1.03.04	Civil Task drawings indicating various equipment loading and supporting arrangement and floor loads shall be submitted along with design calculations. Soft copies of all STAAD/Other Softwares input and output files shall be submitted along with the design calculations for all revisions.		
1.03.05	Structural steel fabrication drawings to be prepared by the contractor will not be approved by the Employer. However, the Contractor shall submit all fabrication drawings for Employer's reference. Copy of detailed bar bending schedule as prepared by contractor shall also be submitted to Engineer in charge for the reference.		
1.03.06	Approval of construction drawings prepared by the contractor shall not relieve the Contractor of his responsibility regarding the safety and adequacy of design and correctness of the drawing.		
1.03.07	<div>"As-built" drawings in AutoCad & PDF format shall be prepared and submitted to owner by the Contractor after completion of construction / erection, incorporating changes, if any.</div> <div>Final executed quantities of RCC and structural Steel shall be incorporated in the As-Built drawing.</div>		
1.03.08	Bidder shall provide tentative Bill of Quantities of RCC, Reinforcement and Structure steel in all the Civil/structural drawings as per scope of respective drawings.		
1.04.00	Inspection, Testing and Quality Control		
1.04.01	<div>Sampling and testing of major items of civil works viz. earthwork, concreting, structural steel work (including welding, sheeting, etc. shall be carried out in accordance with the requirements of this specification. Wherever nothing is specified relevant Indian Standards shall be followed. In absence of Indian Standard equivalent International Standards may be used.</div> <div>The Bidder shall submit and finalise a detailed field Quality Assurance Programme before starting of the construction work according to the requirement of this specification. This shall</div>		
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1.04.02	include frequency of sampling and testing, nature/type of test, method of test, setting of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, Field Quality Plan, etc. Tests shall be done in the field and/or at a laboratory approved by the Engineer. The Bidder shall furnish the test certificate from the manufacturer's of various materials to be used in the construction.			
	Workmanship and dimensional tolerances shall be checked as stipulated else where in the specification.			
1.05.00	Statutory Requirements Bidder shall comply with all the applicable statutory rules pertaining to Factories Act, Fire Safety Rules at Tariff Advisory Committee. Water Act for pollution control, Explosives Act, etc. Provisions of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkways along the crane - girder level on both sides of building, comfortable approach to EOT crane cabin, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc. Provisions for fire proof doors, number of staircases, fire separation wall, lath plastering/encasing the structural members (in fire prone areas), type of glazing etc. shall be made according to the recommendations of Tarrif Advisory Committee. Statutory clearances and norms of State Pollution Control Board shall be followed. Bidder shall obtain approval of Civil/Architectural drawings from concerned authorities before taking up the construction work.			
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D-1-2				
2.00.00	GENERAL LAYOUT PLAN			
2.01.00	<p>The preliminary layout plan proposed for the project is shown in the drawing titled "General Layout Plan".</p> <p>It shall form the basis for further elaboration by the Bidder for the plant facilities, which are in its scope. Area identified for facilities remains same as indicated in GLP, however, minor modification of location of building may be done to optimize layout.</p> <p>Bidder shall prepare the detailed layout of the plant facilities considering the Engine size which are in his scope and shall submit the same for Owner's approval.</p> <p>While preparing the detailed layout, planning his facilities and deciding upon the transportation and erection strategy he shall ensure the following aspects.</p> <ul style="list-style-type: none">a) All Statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws are met.b) Face of the buildings and facilities are located in such a way so as to have an offset of minimum 15m with respect to center line of double lane road and 12 meter with respect to center line of single lane road.c) The entire construction activity shall take into account the commissioning of the unit in phases matching with the phased commissioning of the plant.d) The interface requirements with the plant construction/erection activities of other contracting agencies engaged by Owner. These agencies engaged will be working simultaneously with the Bidder within the plant premises.e) Available Area for laydown has been earmarked on the General Layout Plan.f) Transportation of all equipment and materials shall be by road as envisaged. Any other mode envisaged by the bidder may be proposed.g) All parts of the buildings and facilities shall be approachable by fire tenders.h) Main roads /peripheral roads only are shown in GLP and road layout tender drawing. Approaches made of heavy-duty paving/passage to buildings/structures/facilities in the scope of bidder from nearby plant road/peripheral road/grid road/internal access road is in bidder's scope. Multiple numbers of access to different parts of any building /facility like main plant building, control room, transformer yard, etc. should be provided.i) Layout need to be developed keeping provision for future phases as shown in the tender drawing.			
2.02.00	DELETED			
2.03.00	Site Levelling and Slope Protection Work – Although, Site Levelling work is not envisaged in the present scope, however, slope protection work required for the facilities proposed to be done as per the details below:			
2.03.01	DELETED			
2.03.02	DELETED			
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2.03.03	DELETED			
2.03.04	DELETED			
2.03.05	The surface of the cut/filled up areas after reaching final level shall be dressed to the required levels and slopes. The difference in levels shall not be more than +/- 10cm locally. Grading works upto (+/-) 300mm for achieving the final finished ground level shall also be in the scope.			
2.03.06	DELETED			
2.03.07	DELETED			
2.03.08	DELETED			
2.03.09	DELETED			
2.03.10	DELETED			
2.03.10	Thereafter, it shall be finished at a suitable slope (not steeper than 1Vertical: 2 Horizontal) with Rip-Rap. For slope steeper than 1:2 encountered anywhere, slope protection shall be provided at slope with gabion wall/RCC retaining wall as per the requirement.			
2.03.11	DELETED			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
D-1-3				
3.00.00	FOUNDATION SYSTEM AND GEOTECHNICAL DATA			
3.01.00	<p>Geotechnical data and foundation system for the respective project are enclosed at Annexure-I. The corresponding bore logs are enclosed at Annexure-II.</p> <p>The geotechnical investigation report comprising of Boreholes, Laboratory tests, Chemical analysis, etc for the sub-strata prevailing at site would be made available for the Bidder's study at the Owner's office, if required. The onus of correct assessment / interpretation and understanding of the existing substrata profile / data lies with the Bidder. In case, bidder feels that the available data is inadequate, he may carry out his own geotechnical investigation at no cost to Owner. However, no time extension shall be given on account of soil investigation carried out by the Bidder. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. Net allowable bearing pressure shall be limited to Table-1 of Annexure-I. The report shall be submitted for Owner's approval prior to commencement of design of foundation.</p>			
3.01.01	<p>The furnished borelog details are specific to the co-ordinates where the boreholes have been carried out and are provided for bidder's information only. Substratum profile in the proposed area may vary with respect to the borelogs enclosed for bidder's information. Bidder has to consider all such variations in his estimation, over the extent of the work to be carried out. The Bidder should note that nothing extra whatsoever on account of variation between Substrata profiles collected by Owner and that found by the Bidder during geotechnical investigation by him or during execution of works, shall be Payable.</p>			
3.01.04	<p>Tank Foundations</p> <p>a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil, if any.</p> <p>b) Entire loose/ soft soil inside the concrete ring wall shall be removed and shall be filled with sand. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III.</p> <p>c) Natural sand/ crushed sand as per IS:383 shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers, etc to achieve a relative density of not less than 80%.</p> <p>d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.</p>			
3.02.00	<p>Foundation System</p> <p>The requirements for the foundation system to be adopted are as given in subsequent clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable open foundation shall be adopted with approval of owner.</p>			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.03.00	EXCAVATION IN ROCK Excavation in rock shall be carried out by mechanical means and if blasting is required for founding of some of the structures under this package, control blasting only shall be carried out.			
3.04.01	Controlled blasting shall be done by a specialized agency duly approved by Engineer. All controlled blasting shall be done by using time delay detonators (i.e. excel type).			
3.04.02	a) Contractor shall engage an agency expert in blasting such as, NIRM (National Institute of Rock Mechanics), CMPDIL, Central Institute of Mining and Fuel Research Dhanbad, Dept. of Mining of Govt. Institutions etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme & initial blasting operations shall be done under the supervision & guidance of the representative of the blasting expert. b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed. c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials. d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosive and blasting operations.			
3.04.00	Special Requirements			
3.04.01	Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per detailed geotechnical investigation to be carried out by contractor. Contractor shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.			
3.05.00	Excavation, Filling and Dewatering			
3.03.01	For excavation works, comprehensive dewatering with well point or deep wells arrangement, if required, shall be adopted. Scheme for dewatering and design with all computations and back up data for dewatering shall be submitted for the owner's information. The water table shall be maintained at 0.5m below the founding depth.			
3.03.02	Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or any loose pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M25. The final layer of about 300 mm thickness above the founding level shall be excavated by suitable means, so as to avoid disturbance to founding stratum.			
3.03.03	Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 80% of relative density for non cohesive soils.			
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3.03.04	Founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches / channels.			
3.03.05	CBR tests for pavement/road design shall be carried out by the Contractor after earth filling (if applicable) has been completed upto the formation level.			
3.03.06	<p>The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding of material or article from any bank or side of such excavation which is more than one and a half meter above the footing by providing adequate piling, shoring, bracing etc. against such bank or sides.</p> <p>Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.</p>			
3.06.00	<p>Sheeting & Shoring</p> <p>The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation while executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.</p>			
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D-1-4				
4.00.00	Architectural Concepts and Design			
4.01.00	Architectural Concepts & Design:			
	<div>a) All the Architectural design works shall be carried out by professionally qualified architects having adequate experience (minimum five years) in the design and detailing of architectural work of power plant buildings. Bidder may have in-house Architects with the required experience for the above or engage Architect Consultant having similar experience.</div> <div>b) Power plant buildings shall be architecturally treated, based on functional requirements, in such a way that they retain the desired scale, and present a pleasing composition of mass and void. The overall impact of the buildings shall be one of aesthetically unified architectural treatment having a comprehensible scale, blending colour scheme with the surroundings.</div> <div>c) All buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant building, surrounding structures and environment. Due considerations shall be given to orientation, landscape design, and interior design. All finishes for floors, walls, ceiling, structural elements, partitions for offices and industrial areas shall be suitable for their aesthetics, durability and functional requirements and shall include the latest building material & technology. Consideration shall be given for achieving standardization & fast track construction.</div> <div>d) Overall colour scheme of the buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts, and other service elements.</div> <div>e) For adequate light and ventilation, National Building Code recommendations shall be followed. All buildings having height more than 4.0 m shall have fixed glazed ventilators.</div> <div>f) Architectural design of all Building shall be suitable for installation of solar photovoltaic panels on roof tops for renewable energy purpose.</div> <div>g) All the buildings shall be architecturally designed to meet the National Building Code requirement & Fire Safety Regulations.</div> <div>h) All public buildings shall be designed incorporating the provision of barrier free environment for physically disabled persons.</div> <div>i) All the buildings and site development including landscaping shall be designed to take care of rain water harvesting & ground water recharging. However, if landscaping is excluded from the scope of works, area for landscaping is to be kept.</div> <div>j) For Utility Building in Power Block Area dry wall construction technology shall be incorporated. Control room shall be designed as designer control room with ACP Cladded wall paneling for housing LVS.</div> <div>k) Full glass wall partition with aluminium frame over solid wall with skirting 150 mm</div>			
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	<p>high to be provided between CCR and CER of AHP CR, WS CR & CHP control room and MPH Control room.</p> <p>l) All AC Control rooms, RIO rooms and C&I Panel rooms shall be provided with double door air lock lobby.</p> <p>m) The development of green belt is not in bidder scope. However, bidder has to plan the facilities leaving the space for green belt as indicated in “General Layout Plan”. In addition to that laydown areas and other vacant land of the plant will be used by owner for the development of green belt.</p> <p>n) All floor areas indicated in subsequent pages shall be total floor area required.</p> <p>The total floor Area shall be area enclosed under the outside walls, including the wall thickness, of the building but excluding the following:</p> <p>- Lift shaft, Open staircase, Rainwater downcomer incasements, Sunshades, any floor/ roof projection, terrace area, any other shaft (Electrical/ HVAC, Plumbing), Atrium, porch, balconies, patios and same area multiplied by number of floors.</p> <p>The total floor area shall be maximum of floor area mentioned in technical specifications or Floor area as per tender drawings.</p>			
4.01.01	DELETED			
4.01.02	DELETED			
4.01.03	<p>Main Power House Architectural Features</p> <p>This building shall be of Structural Steel Framed structure and shall be completely covered with external cladding and RCC roof. The external vertical face (herein stated as ‘A’ row) of main power house facing (& adjacent to) the transformer yard and also the two gable ends shall be completely covered with vertical cladding comprising 3.0m high brick wall (on ground floor slab) and single skin profiled vertical metal sheet for the remaining height except for the vertical segment between operating floor & gantry girder bracket level where double skin vertical metal sheet shall be provided.</p> <p>In case of routing of bus-duct is done outside , there shall be a continuous cladding of metal sheeting covering steel structure supporting the bus duct to match the entire elevation. The metal cladding shall be designed to suit the aesthetics of the entire main plant building.</p> <p>In front of the power transformers, RCC fire barrier wall shall be provided as per functional requirement in lieu of brick wall . The above mentioned RCC wall shall be attached with single skin metal sheet on external face.</p> <p>Gable End columns projecting inside Engine hall shall be concealed with single skin profiled metal sheet from operating floor level to crane girder bracket top level.</p> <p>Glazing for A Row & gable end shall be reflective 6mm thick clear toughened glass with Aluminium frame. Hermetically sealed double glazing shall be provided between air</p>			
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	<p>conditioned & non air-conditioned areas. Internal glazed partition inside CCR/CER/Offsite Control Room and B-Row at operating floor level shall be of fire resistant glass having 2 (Two) hour fire rating and with suitable frame. Light weight aerated concrete panels over that 50 mm thick mineral wool insulation with Single Skin Metal Panel cladding shall be provided in exterior of UPS Battery room area and Control Equipment Room area. All internal side of Aerated concrete panel and columns in air-conditioned areas other than CCR in MPH shall be encased with Aluminium Composite panel cladding from inside.</p> <p>Inside the main power house building, brick masonry wall (and fire proof doors) shall be provided for switchgear rooms, cable spreader rooms, MCC rooms, AHU rooms, Air Washer room & Oil rooms and all other rooms where fire protection is envisaged.</p> <p>Cut-outs and opening shall be provided in floors and walls as per functional requirement.</p> <p>All door, windows in air conditioned area and all windows glazing shall be provided with Aluminium frame work Steel door and Fire Proof doors shall be provided as per requirements.</p> <p>Stairs shall be provided as per functional requirement and as per National Building Code and Factories Act.</p> <p>For each unit minimum one no. gent's toilet with adequate facilities including drinking water space and janitor's space shall be provided at each level of power house building, in addition one no ladies toilet shall be provided in each unit at 0.00M and mezzanine floor level and CCR level. A separate ladies and gent's toilet and pantry shall be provided for CCR approachable from CCR / CER / Offsite Control Rooms.</p> <p>Control Room & CER and glazed partitions in CER/ CCR/Offsite Control room shall be of 30 mm thick Hermetically sealed double glass of Fire resistant of min 14mm thick clear, toughened, interlayered 120 minute fire rated for both integrity & radiation control and 6 mm thick toughened tinted glass with 10 mm gap and with suitable fire resistant frame of 1.6 mm thick powder coated steel sheet. The partitions shall be up to false ceiling level and wall above up to the soffit of floor slab above control room and shall be finished with Aluminum Composite panels cladding and shall also have FRP mural of theme matching to local art and Culture.</p> <p>Glass partition between AC areas in CCR/ CER and other areas in associated with CCR/ CER shall be single Fire Resistant glass in line with technical specs as per fire zoning requirement. It shall be single toughned glass minimum 10 mm thick if not within fire zone.</p> <p>In CCR, EIC Room, Conference Room, Programmer's Room and Visitors Gallery etc. a theme based coordinated false ceiling shall be provided with latest state of art design.</p> <p>In CCR, EIC Room, Conference Room, Programmer's Room and Visitor's Gallery etc., vitrified flooring shall be designed with theme and color coordination in line with the designed false ceiling.</p> <p>Mullion-less glass wall with motorized curtain shall be provided in between the control room and the Visitor's gallery.</p>			
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	<p>The fire resistant glass partition in between CER/PADO room & control room (control room left hand side wall) and shift in-charge room/Conference room & control room (control room right hand side wall) shall have motorized blinds (with provision of remote control from Unit in-charge desk) with central metallic panel column having NTPC signature icon.</p> <p>The rest of the walls including LVS wall shall have coordinated design keeping in mind the overall theme of the control room using metallic panels with calcium silicate boards.</p> <p>The control room gates shall have biometric physical security feature with double layer of sliding doors with air lock lobby.</p> <p>Control room interiors shall be designed and executed by the vendor who are specialized in control room interior design.</p> <p>Control room/ Control Equipment Room / Offsite Control Rooms, entire area, False Ceiling shall have Cat Walk Way above for service/ maintenance.</p> <p>Main power house building shall be provided with passenger lift in BC way as specified elsewhere in technical specification.</p> <p>Adequate partitioning as per functional requirement above false ceiling in control Room & CER shall be provided for Inert Gas zoning.</p> <p>Internal steel columns in Air Conditioned Area of Main Power House Building (CER, UPS charger room, SWAS room, etc.) shall be encased with Aluminium Composite Paneling up to false ceiling.</p> <p>Functionally the very heart of Power House Building is its Control Rooms. Special attention shall be given for conceptualization of interior design of the Control Rooms. Control rooms design shall be both functional and ergonomic for ensuring reliable and error free operation of the plant. Control room shall have metallic panels with calcium silicate boards clad video wall housing large video screens and a separate visitor viewing gallery. A walk through view of the control rooms shall be submitted along with bill of quantity to illustrate the design scheme.</p> <p>Metal Panel Cladding shall be composed of Different Colour shades to match with the surroundings. External finish of Masonry wall shall be premium acrylic smooth exterior paint with silicon additives finish.</p> <p>Air Conditioned Office (Including 5 cabins for Senior persons) with Pantry, Toilet block (Ladies and gents toilet separately), conference room, shall be provided in MPH building in addition to other facilities specified. This area shall have access to natural light on three sides minimum. It shall have air lock lobby at entrance with auto sliding doors. Minimum area of office area shall be as specified in Part-A/ IID. This area shall be positioned over the CR with good aesthetic view and noise reduction and dust isolation.</p> <p>The noise reduction and dust isolation shall be done with AAC Panel, Mineral wool insulation, Aluminium composite panels, Fire rated Glass, and Air Lock lobby.</p>		
4.01.04	DELETED		
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4.01.05	Sheds for Construction workers and O&M Workers			
	External finishes shall be Premium smooth Exterior Paint with silicone additives over Texture Coat.			
4.01.06	BIO TOILET			
	Bio-Toilet shall be provided in all the Construction and O&M worker's sheds. Besides these areas, any toilet block provided in area far from plant boundary shall be a Bio-toilet.			
	Bio-toilets shall be made for anaerobic bacterial decomposition of human waste. After decomposition and treatment of the human waste, the residual water from Bio-Toilet shall be: colorless, odorless , devoid of any solid particles and shall have pathogen inactivation by 99%. The water thus obtained shall require no further treatment / waste management and shall be used for irrigation purposes.			
	Bio toilet shall have all fixtures that shall include following fixtures besides the requirements stipulated by DRDO standards.			
	a) One number wall mounted colored (excluding premium colors) glazed vitreous China European water closet and flushing valve system, water faucet, toilet paper holder as per IS:2556			
	or			
	One number white glazed vitreous China Orissa pan (580 x 440 mm) and flushing valve system, toilet paper holder as per IS:2256			
	b) One number colour (excluding premium colors) glazed ceramic oval shaped wash basin 450x 550 mm (approx.) mounted over 20mm thick granite beveled edge counter fitted with photo-voltaic control system for water controls, bottle trap as per IS:2556. For common toilets, number of washbasins shall be as per requirement. However, for Pump Houses the same shall be provided without photo voltaic control system for water control.			
	c) For Male Toilets Urinal as per requirements, with all fittings with photovoltaic control flushing system as per IS: 2556.			
	d) One number looking mirror 600 x 900 x 6 mm, edge mounted with teak beading and minimum 12 mm thick plywood backing, one number stainless towel rail 600 x 20 mm, one number liquid soap dispenser			
	Bio toilet/Bio digester shall be comprised of four compartments and a soak pit. The size of the tank shall be as per the number of users. This four-compartment tank shall be constructed underground and shall be made of FRP with required strength as stipulated by DRDO norms. The bio-toilet constructed shall have S-trap and ball valve for ease of operation and maintenance. It shall have all necessary arrangement and fixture for future operation and maintenance as per manufacturer guidelines.			
	In addition to this permanent sample collection provision(tap/alternate arrangement) to be made before reaching of treated effluent to soak pit. This is to ascertain the quality			
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4.02.00 4.02.01	of effluent at all periods of time and this would also help in the seeding requirement of bacteria.			
	General Architectural Specifications General a) Minimum 1000 mm high (from floor/ roof level) hand railing shall be provided around all floor/roof openings, projections/balconies, walkways, platforms, steel stairs, etc. Wherever the height of the building is more than 12m, railing height shall be 1.2m. All handrails and ladder pipes (except at operating floors) shall be 32 mm nominal bore MS pipes (medium class) conforming to IS: 1161 and shall be finished with suitable paint. All rungs and ladders shall be finished with suitable paint. The spacing of vertical posts shall be maximum 1500mm. Two number of horizontal rails shall be provided including the top member. In addition, toe guard/ kick plate of min size 100x6th shall be provided above the floor level. For handrailing at operating floors of Main Power House including RCC stairs (for one flight above and below operating floor level), passages, around all floor openings shall be Stainless Steel (SS) pipes shall be used. For specification of SS handrail, refer cl 4.16.00. b) Staircase to the technological structures, equipment, pits, pipe/ cable/ conveyor galleries shall be as per functional requirement. All other stairs shall have a maximum riser height of 150mm, minimum tread width of 300 mm and minimum clear width of 1500 mm unless specified otherwise. The width of staircase shall meet the National Building Code requirements. c) All buildings having metal cladding shall be provided with 1 meter high 1 wall at ground floor level. All buildings having metal cladding shall be provided with a 150 mm high RCC toe kerb (on upper floor) at the edge of the floor along the metal cladding. 1200 mm high hand railing shall be provided on this RCC kerb, wherever required from the safety point of view. d) In all buildings, structures, suitable arrangement for draining out water collected from equipment blowdowns, leakages, floor washings, firefighting, etc., shall be provided for each floor. All the drains shall be suitably covered with grating or precast RCC panels. e) RCC steps / staircase shall be provided for main entrance of all RCC construction buildings. f) RCC Parapet, of 1000 mm high from Finished floor level of roof for accessible roof and of 600 mm high from Finished floor level of roof for Non accessible roof, Parapet, Sunshades of 450mm over window, 600mm over door and 900mm over rolling shutters, architectural facia, projections, etc., shall be provided with drip course in cement sand mortar 1:3. Minimum 600mm wide roof projection shall be provided at terrace level in all buildings. g) All fire exits shall be painted with fire resistant paint P.O red/signal red colour shade which shall not be used anywhere except to indicate emergency or safety measure. Fire safety norms shall be followed as per National Building Codes and fire safety requirements for providing fire exits, escape stairs and firefighting equipment. In			
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<p>4.03.00</p> <p>4.03.01</p> <p>4.03.02</p>	<p>detailing of all buildings, fire safety requirements conforming to IS: 1641 and IS:1642 shall be followed.</p> <p>h) Ramps & Lifts for Physically challenged persons shall be provided for barrier free access to public building.</p> <p>i) All electrical conduits in buildings for lighting, Air-conditioning, other services shall be of concealed type. Conduits shall be laid in RCC structures at the time of casting.</p> <p>j) Wherever the area of building at any floor is more than 500 sq.m. Minimum two no of staircase shall be provided. Number of staircases shall also be governed by Electrical Safety Rules.</p> <p>Water Supply and Sanitation</p> <p>Roof water tanks of adequate capacities depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tanks conforming to IS:12701 shall be used. The tanks shall be complete with all fittings including lid, float valve, stop cock, vent pipe, etc.</p> <p>Chlorinated Polyvinyl Chloride (CPVC) pipes, confirming to IS 15778, having thermal stability for hot & cold water supply including all CPVC plain & brass threaded fittings shall be used for internal piping works for service water and potable water supply. For installation of CPVC pipes guidelines as stipulated in Clause No. 18.9 of CPWD specifications shall be followed.</p> <p>UPVC (conforming to IS:13592) shall be used for sanitary works above ground level.</p> <p>All Buildings shall be designed with Toilets as per NBC norms.</p> <p>All buildings shall have minimum one toilet block each. The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated in subsequent clause. IS:1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation.</p> <p>In addition, IS:2064 and IS:2065 shall also be followed.</p> <p>Each Toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of Chromium plated brass (decorative type)</p> <ol style="list-style-type: none"> One number wall mounted coloured glazed vitreous China European water closet and dual flushing valve system, water faucet, health faucet, toilet paper holder as per IS:2556. One number colour glazed ceramic oval shaped wash basin 450x 550 mm (approx.) mounted under the counter with 18mm thick granite beveled edge counter fitted with photo-voltaic control system for water controls, bottle trap as per IS:2556. For common toilets, number of washbasins shall be as per requirement. However, for Pump Houses the same shall be provided without photo voltaic control system for water control. For Male Toilets Urinal as per requirements, with all fittings with photovoltaic control flushing system as per IS: 2556. One number looking mirror 600 x 900 x 6 mm, edge mounted with teak beading/SS Studs and minimum 12 mm thick plywood backing, one number stainless towel rail 600 x 20 mm, one number liquid soap dispenser One toilet with required facilities shall be provided for physically challenged persons on Ground floor of Main Power House Building. 		
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	<p>f. Janitor Space & space for drinking water cooler.</p> <p>g. Electric operated hand dryer with photo voltaic control.</p> <p>h. In addition to the facilities stipulated elsewhere Bathroom with rotating type chromium plated shower including all fitting and fixtures shall also be provided in toilet at ground and operating floor of Main Power House Building.</p>			
4.03.03	<p>The pantry shall consist of one number stainless steel pantry sink, as per IS : 13983, of size 610 x 510 mm, bowl depth 200 mm with drain board of at least 450 mm length with coupling , CP bottle trap, hot and cold water mixer, one number geyser of 25 liters capacity, with inlet and outlet connections, one number over head water storage tank, as per IS : 12701 and of minimum 500 liters capacity, complete with float valve, overflow drainage pipe arrangement, CPVC concealed water supply pipe of minimum 12 mm diameter, CPVC sanitary pipe (with lead joints) of minimum 75 mm diameter, floor trap with Stainless Steel grating, inlet and outlet connections for supply and drainage, with all bends, tees, junctions, sockets, etc., as are necessary for the commissioning and efficient functioning of the pantry (all sanitary fittings shall be heavy duty chrome plated brass, unless noted otherwise).Steel grating, inlet and outlet connections for supply and drainage, with all bends, tees, junctions, sockets, etc., as are necessary for the commissioning and efficient functioning of the pantry (all sanitary fittings shall be heavy duty chrome plated brass, unless noted otherwise)</p> <p>One number of pantry shall be provided on Control Room floor of ESP control room building and One number of pantry shall be provided in Buildings having Control Room.</p>			
4.03.04	<p>a) Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS: 2556 (Part-5)with single 15 mm C.P. brass pillar taps with elbow operated levers ISI Marked.</p> <p>b) In addition, adequate number of portable toilet units with adequate plumbing and sanitary arrangement, shall be provided during construction stage for workers.</p> <p>c) Adequate number of toilet units with necessary plumbing and sanitary arrangement, shall be provided for workers (O&M workers).</p>			
4.03.05	Deleted			
4.04.00	Flooring <p>Floor finishes of approved shade and colour over under bed of cement mortar / concrete, at all levels and for all kind of works, elevations, on horizontal and vertical surfaces for all types of work (like flooring, skirting, dado, wall lining & facing, tread and risers etc.), including topping, spreading white cement slurry at an average rate of 2.5 kg/Sq. M., (unless noted otherwise), jointing and joint filling with white cement (unless noted otherwise) slurry mixed with colour pigment, to match the shade of the finishing material, laying to plumb and water level in desired pattern, line and flush butt square jointing, curing, rubbing, grinding, polishing, edge moulding, finishing and cleaning, testing, providing opening of required size and shape, casting in panels wherever specified.</p>			
4.04.01	<p>The nominal total thickness of floor finish shall be 50/70 mm i.e. underbed and topping. The floor shall be laid on an already laid and matured concrete base. The underbed for floors and similar horizontal surfaces shall consist of cement concrete M20 grade. Stone chips shall be 12.5 mm down well graded & proper filling shall be done with brick bats/cinders. Flooring like Tiles/ Stones shall be laid with 1:4 cement sand mortar and Tile/ Stone Cladding on wall shall be laid with 1:3 cement sand mortar.</p>			
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4.04.02	<p>All toilets shall have sunken slab to accommodate sanitary pipes and the finish level of floor shall match with general floor finish level. Sunken slabs shall be made watertight by suitable water proofing treatment.</p> <p>Water proofing treatment in sunken portion of WCs, bathroom, kitchen, pantry etc., shall be done in two (2) coats by applying cement slurry mixed with water proofing cement compound (confirming to IS 2645).</p> <p>The First layer shall be of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/ sqm. This layer shall be allowed to air cure for 4 hours.</p> <p>The Second layer shall be of slurry of cement @ 0.242 kg/sqm mixed with water proofing cement compound @ 0.126 kg/sqm. This layer will be allowed to air cure for 4 hours followed with water curing. The water proofing shall be done for the entire sunken area.</p>		
4.04.03	<p>Metallic Hardener Topping shall be 12 mm thick. Metallic Hardening Compound shall be of approved quality consisting of uniformly graded iron particles, free from non-ferrous metal particles, oil, grease sand, soluble alkaline compounds. The ratio of Metallic hardener and Cement shall be 1:4. This mix shall be mixed with 6mm nominal stone in Ratio of 1mix : 2 stone. The mixture so obtained shall be laid in 12 mm thickness, on cement concrete floor within 2 to 4 hours of its laying. For laying, the top surface pf underbed shall be roughened with brushes while the concrete is still green and the forms/strips shall be kept projecting up 12 mm over the concrete surface, to receive the metallic hardening compound topping. The topping shall be laid true to provide a uniform and even surface. It shall be firmly pressed into the bottom concrete to have good bond with it. After the initial set has started, the surface shall be finished smooth and true to slope with steel floats</p>		
4.04.04	<p>Heavy duty cement concrete tiles 300 mm x 300 mm shall be provided using white cement with pigment, with hard and abrasion resistant carborundum / quartz chips for wearing course as per IS:1237. Laying of tiles shall be as per IS: 1443.</p>		
4.04.05	<p>Digitally glazed ceramic tiles shall be as per IS: 15622. Designer digitally glazed ceramic floor and wall tiles shall be as follows -</p> <p>a) 300x600mm in DIGITAL series (beige colour / grey colour)</p>		
4.04.06	<p>12mm/20mm / 38mm / 75 mm/ 115mm thick acid resistant tile on horizontal and vertical surfaces, at all levels for all type of works shall include one coat of bitumen primer followed by 12 mm thick bitumastic layer, 20mm / 38mm/ 75 mm / 115mm thick A.R. tiles, 6 mm thick under-bed by potassium silicate mortar conforming to IS:4832 (Part-I), pointing of joints of tiles with acid/alkali resistant epoxy/furane mortar conforming to IS:4832 (Part-I), up to a depth of 20 mm and bitumastic end sealing.</p> <p>Battery Room in all buildings shall be provided with acid/ alkali resistant tiles on flooring & dado 1200mm high.</p>		
4.04.07	<p>(i) Digitally glazed vitrified & Matt Finish Digitally glazed Vitrified tiles with 3mm groove joints as per approved pattern pointed neatly with 3x4mm stainless epoxy grout mix of 0.70kg of organic coated filter of desired shade (0.10kg of hardener and 0.20kg of resin per kg) with sizes of the tiles shall be as under:</p> <p>a) Vitrified Tile, Size of tile 600mm x 600mm (beige colour / grey colour)</p> <p style="text-align: center;">and</p> <p>ii) Anti-Skid Full Body Vitrified Tiles</p>		
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	<p>Antiskid, full body Vitrified Tiles of size 600X600X20 mm thick (beige colour / grey colour) as specified below of approved make, shade, colour and pattern, over under bed of cement mortar / PCC shall be provided in flooring at operating level. Full body Vitrified Tiles shall be laid on properly laid leveled floor, with joints 3 to 5 mm wide & 8 to10 mm deep & shall be filled with approved Epoxy Grout mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardener and 0.20 kg of resin per kg).</p> <p>Full body Vitrified Tiles shall have water absorption less than 0.5%, Modulus of Rupture more than 38N/mm2, Breaking strength more than 7500 N, Mohs scale more than 6, Abrasion resistance less than 144 mm3 and coefficient of friction more than 0.4. Vitrified Tiles shall generally conform to IS: 15622</p>			
4.04.08	For pathway, chequered and designed concrete tiles minimum 22 mm thick, 200x200 mm size conforming to IS: 13801 of approved shade and colour shall be used. 1000 wide pathways shall be provided for maintenance on rooftops of all buildings.			
4.04.09	Epoxy Flooring <p>Epoxy Flooring shall be provided with surface preparation of concrete substrate with Captive Shot Blasting Machine OR Light Grinding to form the required anchor profile on the floor substrate followed by application of epoxy resin-based moisture barrier underlay of 2 mm thickness including filling of saw cut joints with epoxy cementitious resin-based moisture barrier underlay as per manufacturer specification. Application of self-smoothing epoxy floor topping of epoxy based resin of 2 mm thickness over epoxy resin based moisture barrier underlay including application of solvent free epoxy resin based two component primer.</p> <p>It shall include application of PU Sealant at Expansion and Isolation Joint respectively including surface preparation of the joint, fixing of backup strip and application of sealant.</p>			
4.04.10	18mm thick Rajnagar white polished marble			
4.04.11	Mirror polished (6 layers of polish) Granite stone (slab) (black colour / sadarali grey colour) - 18 mm thick (minimum) / Flame finish/ (making top surface rough by burning)/ honed finish granite stone (slab) - 18 mm thick (minimum) shall be provided.			
4.04.12	Decorative/designer prepolished, plain and pigmented, high wearing resistance concrete tiles of 20mm thickness (minimum) in various non-standard interlocking patterns.			
4.04.13	Skirting in general shall be 150 mm high. Dado in toilets & pantries, shall be up to false ceiling level from finished floor level. Skirting and Dado shall match with the floor finish.			
4.04.14	Interlocking concrete blocks shall be of various sizes and thickness having ade of concrete and pigmented to specified colours, in different pattern (in different textures chequered or other patterns in indentation for guiding band/s for visually impaired persons) including the preparation of sub base with 20mm thick sand and filling of joints with sand.			
4.04.15	Matt finish (with grooves) Porcelain tiles (for guiding band/s for visually impaired persons in service building) shall be with 3mm groove joints as per approved pattern pointed neatly with 3x4mm stainless epoxy grout in approved colour to match colour of tile.			
4.04.16	Rubber Flooring			
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4.05.00	Rubber flooring shall conform to IS 809. The minimum thickness shall be 4 mm with sheet size of 602mm x 602mm. Rubber flooring shall consist of 100% virgin elastomer reinforcing agents, resins, curing agents, anti-oxidants and pigments. It shall have excellent abrasion resistance and shall have class-I fire rating. It shall be acid & alkali resistant and shall be of anti-static grade. In general, BS code shall apply for their technical characteristics			
	Epoxy Resin Floor Finish			
	Self-smoothing, seamless epoxy resin floor finish shall be provided on horizontal and vertical surfaces including preparation of surface, application of epoxy-based primer coat, of approved colour, quality and make to give minimum thickness of 300 micron (in two coats).			
	4.06.00	Roof		
	4.06.01	Except for the roofs subjected to heavy loads, roof of all buildings having structural steel framework shall consist of permanently colour coated (on exposed face) troughed metal sheet decking of approved profile as specified in clause 4.08.00. Silicon modified polyester paint having DFT of minimum 20 microns shall be used for permanent coating. The sheeting shall be fixed by means of concealed fixing system or any other compatible method approved by the Engineer. RCC slab of minimum 40 mm clear thickness in excess of trough depth shall be provided over the metal decking. Water proofing cum plasticiser compound shall be added to concrete over the metal decking. Bidder shall demonstrate that the roof is leak proof by carrying out the water-retaining test by maintaining the minimum water depth of 50mm over the roof surface for a period of 48 hours. Water Proofing Treatment as given below for RCC roof slabs shall be provided to ensure that the roof is watertight.		
4.06.02	DELETED			
4.06.03	For efficient disposal of rainwater, the runoff gradient for the roof shall not be less than 1:100 and the roof shall be provided with RCC water gutter, wherever required. Gutter shall be made watertight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface.			
4.06.04	Unplasticized PVC rain water pipes conforming to IS 13592 , Type A with joints with seal ring confirming to IS 5382 shall be provided to drain off rain water from the roof. These shall be suitably concealed with masonry work, cement concrete / or sheeting work to match with the exterior finish. The number and size of down comers shall be governed by IS 1742 and IS 2527. Roof drain level of all RCC framed buildings having cast-in-situ RCC roof shall be provided with Rain water gutter and/or 45 x 45 cm size Khurras having minimum thickness of 30 mm with 1:2:4 concrete over PVC sheet of 1 m x 1 m x 400 micron and finished with 12 mm thick cement sand plaster 1:3. All the pipes shall be provided with suitable fittings and fixtures.			
4.06.05	Roof Water Proofing			
	Roof water proofing treatment shall be as follows:			
	a) For roofs having structural slope:			
	Top surface of sloped R.C.C. slab shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid. The elastomeric shall comprise of high solid content liquid applied urethane laid over reinforcing layer of polyscrim cloth or non woven geo-textile. The top of the elastomeric membrane shall			
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	<p>be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at dry stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also.</p> <p>b) For roofs having no structural slope:</p> <p>Screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope shall be laid over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of grading underbed shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid and top of the elastomeric membrane shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at dry stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also.</p> <p>The elastomeric membrane as mentioned above in (a) and (b) for waterproofing shall be of two component, instant setting, 100% solids spray applied hybrid polyurea polyurethane liquid applied elastomeric seamless waterproofing membrane meeting the requirements of LAM as per ASTM C836 and having excellent tensile strength of 15MPa (As per ASTM D412), elongation more than 450% (as per ASTM D 412), tear strength of 60 Kn/m (As per ASTM D1004/ASTM D624), adhesion to concrete of 2MPa (as per ASTM D 4541), abrasion resistance of 60mg loss (1 Kg,CS 10 Wheels,1000 cycles - As per ASTM D4060), Shore A Hardness of 85 (As per ASTM D2240), resistance to hydrostatic pressure head of 7 Bar (As per ASTM D 5385/ DIN 16726), puncture resistance of 1000N (As per ASTM E154), water vapour permeability of 25 mg/m2/day (As per ASTM E96), Impact resistance of 17 N.m (As per ASTM D2794), Low temperature crack bridging ability up to 3.2mm (As per ASTM C 1305), dynamic crack bridging ability class B 3.2 (as per EN 1062-7 Method B- B3.2) with no crack observed in the coating after 20000 sinusoidal cycles, resistance to root (As per CEN TS/14416) and fire resistance of class B (As per EN 13501-1).The coating shall be applied with a total consumption of 1.6 Kg/Sqm to achieve a total system DFT of 1.5mm, thereby satisfy the requirements of LAM as per ASTM C898 and shall be applied on the entire horizontal surface extending up to 300mm above the FFL on the vertical surface as per the methodology.</p> <p>The application system includes base preparation of cleaning, brushing and removal of flaky materials, grouting the porous area with cementitious grout, proper coving between slab and wall junctions and priming the surface with two component solvent free epoxy primer which is applied with a consumption of 200 grams per Sqm, followed by spray application of hybrid polyurea waterproofing coating.</p> <p>Protective geo textile fabric of minimum 150GSM over the entire membrane with proper overlaps shall be applied.</p>			
4.06.06	Roof of all buildings shall be provided with access/ approach through staircase. Roof where equipment and Solar PV is mounted shall be provided with access through staircase.			
4.06.07	RCC parapet wall of minimum 1000 mm height (above top of slab) with coping for all accessible roofs and 600 mm height for all non-accessible roofs shall be provided.			
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	Alternatively, parapet wall comprising structural steel post, runner and sheeting may be provided for buildings with metal sheet cladding.		
4.06.08	Fillets at junction of roof and vertical walls shall be provided with cast-in-situ cement concrete (1:1.5:3) nominal mix followed by 12mm thick 1:4 cement sand plaster.		
4.06.09	Pathways for handling of materials and movement of personals shall be provided with 22mm thick chequered cement concrete tiles as per IS:13801 for a width of 1000mm.		
4.06.10	Deleted		
4.07.00	Walls		
4.07.01	All walls shall be non-load bearing infill panel walls.		
4.07.02	For initial height up to 1 metre in buildings one brick thick masonry wall shall be provided wherever metal cladding is specified.		
4.07.03	All internal walls shall be with one brick thick in cement mortar (1:6). However, internal partition walls for toilets shall be with half brick masonry thick with cement mortar (1:4).		
4.07.04	DELETED		
4.07.05	DELETED		
4.07.06	50 mm thick DPC in Cement concrete (1:1.5:3) with water proofing compound followed by two layers of bitumen coating 85/25 grade as per IS: 702 @ 1.7 kg./sq.m. shall be provided at plinth level before starting the masonry work.		
4.07.07	Enclosure of the elevator shall have 2hours fire rating and it shall be sealed from outside to ensure dust free environment.		
4.07.08	For construction of brick wall above/ below steel beams, following methodology may be adopted prior to construction of brick wall: a) 12mm diameter anchoring bars (min 150mm embedment into the wall) at approx. 450mm-500mm c/c spacings shall be welded to steel wall beams at contact points, and b) Plastering (lathe) on steel sections (box) shall be done using 1:3 cement sand mortar (minimum 50mm thick all around) with hexagonal galvanized wire netting (0.8 mm wire diameter and 19 mm mesh size-confirming to IS:3150). For I-sections, minimum 125mm thick M25 grade concrete shall be provided instead of plastering. Painting of these steel beams shall be carried out as specified elsewhere.		
4.08.00	COLOUR COATED AND OTHER SHEETING WORK Sheeting Procurement takes considerable time therefore advance supply of the sheeting material shall be ensured to meet site requirements and the project schedule.		
4.08.01	Material		
a)	Wall Cladding & Roofing Material Troughed permanently colour coated sheet of approved shade and colour shall be i) either of steel with minimum 0.6mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating/ Zinc Aluminium Magnesium Coating and painting) of grade YS250 as per IS 15961 / Cold rolled structural quality steel with yield strength 250 as per IS 18513 grade G250 as per AS1397 / grade SS255 as per ASTM A653M or A792M / grade S250GD as per EN 10326		
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b)	<p>with zinc coating to class Z350 / aluminium-zinc alloy coating to class AZ200/ Zinc-Magnesium Coating ZM120</p> <p>ii) or of minimum 0.5mm BMT (i.e. excluding the thickness of galvanizing/ Zinc Aluminium-zinc coating and painting) of grade YS350 as per IS15961/ Cold rolled structural quality steel with yield strength 350 as per IS 18513/ grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A653M or A792M / grade S350GD as per EN 10326 with zinc coating to class Z350 / aluminium-zinc alloy coating to class AZ200/ / Zinc-Magnesium Coating ZM120</p> <p>iii) or of steel of minimum 0.4mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade YS550 as per IS 15961/ Cold rolled structural quality steel with yield strength 550 as per IS 18513/ grade G550 as per AS1397 / grade SS550 as per ASTM A653M or A792M / grade S550GD as per EN 10326 with zinc coating to class Z350 / aluminium-zinc alloy coating to class AZ 200/ / Zinc-Magnesium Coating ZM120</p> <p>Alternatively aluminium feed material of minimum bare metal thickness of 0.7 mm of aluminium alloy of Series 31000 and above as per IS 737 and IS: 1254.</p> <p>Bidder to ensure that same profile is to be used throughout the package for all facilities to maintain uniformity.</p>			
	<p>Metal Deck Roof Material</p> <p>Troughed permanently colour coated metal decking sheets shall be</p> <p>i) either of steel with minimum 0.8mm bare metal thickness (i.e. excluding the thickness of galvanizing and painting) of grade G250 as per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 with zinc coating to class Z350.</p> <p>ii) or of minimum 0.6mm BMT (i.e. excluding the thickness of galvanizing and painting) of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792MA653M/ grade S350GD as per EN 10326 with zinc coating to class Z350.</p> <p>iii) or of steel of minimum 0.6mm BMT (i.e. excluding the thickness of galvanizing and painting) of grade G550 as per AS1397 / grade SS550 as per ASTM A792MA653M/ grade S550GD as per EN 10326 with zinc coating to class Z350.</p> <p>Thickness tolerance of (+/-) 0.04mm is permissible. However, all design calculations shall be carried out on the basis of lowest value of sheet thickness provided.</p> <p>Bidder to ensure that same profile is to be used throughout the package for all facilities to maintain uniformity. In addition, the depth of the profile shall be restricted to 60 mm (maximum) to reduce the overall thickness of floor slab and thus minimizing the dead load of the floor slab. If the bidder proposes to use two different metal deck sheets (same profile but different grades or thicknesses), the unexposed (concrete) side of the metal deck sheets shall be painted with clearly distinct colours to facilitate identification.</p>			
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4.08.02	<p>Bidder to ensure that both cladding sheet and decking sheet supplied at site to be provided with transparent organic film of thickness of 40 microns on each face. Also they should be stored in a covered place on wooden sleepers till erection.</p> <p>Colour Coating</p> <p>Steel shall be colour coated with total coating thickness of at least 40 microns (nominal) comprising of silicon modified polyester (SMP) paint or Super Polyester paint or SDP paint (Super Durable Polyester with no TGIC Triglycidylisocynurate) . The silicon content in the SMP paint to be 30 to 50%. The paint to be of minimum 20 microns (nominal) dry film thickness (DFT) on external face over primer coat of minimum 5 microns (nominal) and minimum 10 microns (nominal) SMP or super polyester paint over primer coat of minimum 5 microns (nominal) on internal face. SMP and Super polyester paint/SDP systems shall be of industrial finish of product type 4 of AS/NZ2728.</p> <p>Also the heavy metal content (Lead, Cadmium, Chromium etc) to be within environmental norms so that the sheet is also suitable for rainwater harvesting.</p>			
4.08.03	<p>Design Criteria</p> <p>For wall cladding insulated / uninsulated and conveyor gallery sides and roof, permanently colour coated sheet of troughed profile shall be used. However alternative profile meeting the strength, deflection and other functional requirements such as section modulus and moment of inertia shall be provided.</p> <p>Sheet shall be of profile, sectional properties, colour and shade as per specifications.</p> <p>For profiled metal decking sheets (to be used for RCC floor slab or roof slab) the sectional modulus and moment of inertia of troughed profile per meter width shall be so as to limit the deflection of sheets to span/250 under total super imposed loading (DL +LL) comprising the self-weight of metal deck sheet, dead weight of green concrete and an additional construction load 100kg per sq.m for two span conditions. The section modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS 801 for satisfying the deflection and strength requirements.</p> <p>For metal deck sheets used for roofing (with or without RCC) and side cladding, the sectional modulus and moment of inertia of troughed profile per metre width shall be such that the deflection of sheets is limited to span/250 under design wind pressure for two span conditions. The sectional modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS 801 for satisfying the deflection and strength requirements. No increase in allowable stress is permissible under wind load condition.</p>			
4.08.04	<p>Fasteners</p> <p>Side cladding/roofing/decking sheets shall be fixed to the runner/purlins using self-drilling special coated fasteners confirming to corrosion resistant class 3 of AS3566 and tested for 1000 hours salt spray test. Spacing of Self-drilling fasteners in transverse direction (along runners/purlin) shall be equal to the pitch of trough or 250(+/-100) mm, whichever is lesser and in longitudinal direction at every runner/purlin location.</p> <p>Shear anchor studs shall also be provided through metal deck, which are to be used as permanent shuttering, at regular interval on all top flange / flange plate of structural beams as specified in Clause no. 6.07.00.</p>			
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4.08.05	<p>Alternatively, J/U type hooks shall be used in roofing which shall be provided in transverse direction (along runners/purlin) at a spacing equal to the pitch of trough or 250(+/-100) mm, whichever is lesser and in longitudinal direction at every runner/purlin location.</p>				
	<p>Miscellaneous Details</p> <p>To minimize the number of joints, the length of the sheet shall preferably be not less than 4.5m, cut pieces shall not be used, unless specifically approved by the Engineer. However, the actual length shall be such so as to suit the purlin / runner spacing.</p> <p>Lap between the sheets shall be at least 150mm in the longitudinal direction and at least one crest wide in the transverse direction which shall be properly anchored / fixed with fasteners.</p> <p>Z spacers if required shall be made of at least 2 mm thick galvanised steel sheet of grade 350 as per IS 277</p> <p>Sealant used for cladding shall be butyl based, two parts poly sulphide or equivalent approved, non stainless material and be flexible enough not to interface with fit of the sheets</p> <p>Filler blocks as a trough filler shall be used to seal cavities formed between the profiled sheet and the support or flashing. The filler blocks shall be manufactured from black synthetic rubber or any other material approved by the Engineer.</p> <p>For insulation of cladding and other areas, mineral wool conforming to IS 8183 shall be used. The density shall be 32 or 48 kg. /cu.m for glass or rock wool respectively. The nominal thickness of insulation shall be 50mm.</p> <p>All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and any weather/moisture sealants with appropriate material and coating specification as mentioned above for the outer face of the metal cladding. Overlap shall be min. 150 mm or as specified by manufacturer.</p> <p>The Bidder shall prepare working drawings of sheeting system including end and side laps, flashing, fixing details etc. before starting sheeting work at site.</p>				
4.08.06	<p>Pre-Fabricated Insulated Metal Sandwich Panels</p> <p>For buildings where Pre-Fabricated (Factory made) Insulated Metal Sandwich Panels shall be used for Roofing, the sandwich panels shall comprise top sheet as troughed permanently colour coated sheet & bottom sheet as plain permanently colour coated with 50mm thick insulation sandwiched between the two sheets. Each sheet shall be</p> <p>i) either of steel with minimum 0.6mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating/ Zinc-Aluminium Magnesium Coating and painting) of grade Y250 as per IS15961/ Cold rolled structural quality steel with yield strength 250 as per IS 18513 / Cold formed structural quality grade G250 as per AS1397 / grade SS255 as per ASTM A653M or A792M / grade S250GD as per EN 10326 with zinc coating to class Z350 / aluminium-zinc alloy coating to class AZ200 / Zinc – Aluminium Magnesium coating ZM120</p> <p>ii) or of minimum 0.5mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating/ Zinc-Aluminium Magnesium Coating and painting) of grade Y350 as per IS15961/ Cold rolled structural quality steel with yield strength 350 as per IS 18513 / grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A653M or A792M / grade S350GD as per EN 10326 with zinc coating to class Z350 /</p>				
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	<p>aluminium-zinc alloy coating to class AZ200/ Zinc – Aluminium Magnesium coating ZM120</p> <p>iii) or of steel of minimum 0.4mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating Zinc-Aluminium Magnesium Coating and painting) of grade Y550 as per IS15961/ Cold rolled structural quality steel with yield strength 50 as per IS 18513/ grade G550 as per AS1397 / grade SS550 as per ASTM A653M or A792M / grade S550GD as per EN 10326 with zinc coating to class Z350 / aluminium-zinc alloy coating to class AZ200/ Zinc – Aluminium Magnesium coating ZM120</p> <p>Metal sheets (steel or aluminium) shall be colour coated with total coating thickness of at least 40 microns (nominal) dry film thickness (DFT) comprising of Silicon Modified Polyester (SMP with silicon content of 30% to 50%) paint or Polyester paint, of minimum 20 microns (nominal) SMP or polyester paint on one side (exposed face), over minimum 5 micron (nominal) primer coat and minimum 10 micron (nominal) SMP or Polyester paint over minimum 5 micron (nominal) primer coat on other side. SMP and Super Polyester paint shall conform to product type 4 of AS/NZS 2728. Troughed sheet shall be of approved profile, sectional properties, (suitable for the specified loading / deflection and purlins / runners spacing), colour and shade.</p> <p>Special coated fastener conforming to corrosion resistant Class 3 of AS3566 and tested for 1000 hours salt spray test shall be used for fixing Pre-Fabricated Insulated Metal Sandwich Panels with the structural members below.</p> <p>The Bidder shall prepare working drawings of sheeting system including end and side laps, fixing details etc. before starting sheeting work at site. The insulation shall be of Polyurethane type. The polyurethane shall be Chlorofluorocarbon (CFC) free and self-extinguishing and shall conform to IS 12436: 1988. It shall have Modular Density 40 +/- 2 Kg/m3 and Thermal Conductivity @ 10 Deg.C 0.017 - 0.020 W/M 0k, Water absorption (% by vol) 3.1, Critical Oxygen Index 23 and Compressive Strength 1.2 Kg/sq.cm.</p>			
4.08.07	<p>Polycarbonate Sheets</p> <p>The polycarbonate sheet to be used for cladding and glazing purpose in conveyor galleries, Transfer points & pump houses shall have toughed profile to match with the metal cladding profile. Minimum 3.0mm thick fire/flame retardant and UV resistant polycarbonate clean sheet of approved make shall be used. The polycarbonate sheet shall be installed along with the metal cladding so as to have a watertight lapping arrangement. Suitable detailing shall be made to cater for the thermal expansion. IS 14434 to be referred for other details.</p>			
4.09.00	<p>Plastering</p>			
4.09.01	<p>Outer face (i.e. rough side) of all brick walls shall have 18 mm thick and inner face (i.e. smooth side) of all walls shall have 12 mm thick cement sand plaster 1:6.</p>			
4.09.02	<p>Acrylic wall putty in two coats shall be applied over cement plastered surfaces in interior of building. The finish surface shall be smooth and shall be of 2 mm nominal thickness.</p>			
4.09.03	<p>All R.C.C. walls shall have minimum 12mm thick cement sand plaster 1:6.</p>			
4.09.04	<p>All RCC ceilings (except areas provided with false ceiling, cable vault ceiling and metal decking) shall be provided with 6mm thick cement sand plaster 1:4.</p>			
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4.09.05	Groove of uniform size 12 x 12 mm up to 20 x 15 mm in plastered surface as per approved pattern, shall be provided as per approved drawing.		
4.09.06	All plastering work shall conform to IS: 1661.		
4.10.00	Painting, Aluminium Composite Panel		
4.10.01	All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller.		
4.10.02	All paints shall be of approved make including chemical resistant paint.		
4.10.03	Minimum 2 finishing coats of paint shall be applied over a coat of primer. Stone work for wall lining etc. (Veneer work) over 20 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand) and jointed with grey cement slurry @3.3kg/sq.m, including rubbing and polishing in complete. (Black polished granite stone slab, 18 mm thick / polished Sadarhally grey granite slab 18 mm thick / 18mm thick Rajnagar white polished marble). The final, finished coating shall be fungus resistant, UV resistant, water repellent, alkali resistant, and extremely durable with colour fastness.		
4.10.04	Acrylic emulsion paint shall be as per IS: 15489. Acrylic distemper shall be as per IS: 428. Cement paint shall conform to IS: 5410, whitewash /colour wash shall conform to IS: 627. Acrylic emulsion paint/ distemper shall be of RAL 9001 colour.		
4.10.05	All fire exits shall be painted in post office red/signal red colour shade, which shall not be used anywhere else except to indicate emergency or safety measure.		
4.10.06	For painting on concrete, masonry and plastered surface IS: 2395 shall be followed. For painting on woodwork IS: 2338 shall be followed.		
4.10.07	For painting on steel work and ferrous metals, BS: 5493 and IS: 1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.		
4.10.08	Bitumen primer used in acid/alkali resistant treatment shall conform to IS: 158.		
4.10.09	All internal paints shall be of low VOC (Less than 50 g /L) content.		
4.10.10	Aluminium Composite Panel Aluminum Composite Panel cladding with open grooves shall be designed, fabricated, tested installed and fixed for linear as well as curvilinear portions of the building for all heights and levels including: a) Structural analysis & design and preparation of shop drawings for pressure equalization or rain screen principle as required, proper drainage of water to make it watertight including checking of all the structural and functional design. b) Aluminium Composite Panel cladding in pan shape in metallic/ solid colour of approved shades made out of 4mm thick aluminium composite panel. ACP consisting of 3mm thick Fire Retardant mineral filled Core comprising of around 70% Inorganic compound which is 100% non-combustible mineral and balance 30% is food grade virgin polymer sandwiched between two Aluminium sheets (each 0.5mm thick). The aluminium composite panel top and bottom skin should confirm to Aluminium Alloy 5005 (AlMg 1) marine grade series and H 22/24 temper. The ACP sheet shall be coil coated with (70:30 ratio) PVDF / fluoropolymer resin coating of approved colour and shade on face # 1 and polymer (Service) coating on face # 2 as		
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4.10.11	<p>specified using stainless steel screws, nuts, bolts, washers, cleats, weather silicone sealant, backer rods etc.</p> <p>The fastening brackets of Aluminium alloy 6005 T5 / MS with Hot Dip Galvanised with serrations and serrated washers to arrest the wind load movement, fasteners, SS 316 Pins and anchor bolts of approved make in SS 316, Nylon separators to prevent bi-metallic contacts all complete required to perform as per specification and drawing.</p> <p>Exterior Painting on Wall (Premium Acrylic Smooth Exterior Paint with Silicone Additives over Texture Coat)</p> <p>The paint shall be (premium acrylic smooth exterior paint with silicone additives) of approved brand and manufacture.</p> <p>Preparation of Surface</p> <p>For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement.</p> <p>Textured base coat</p> <p>Exterior wall Texture-New work (Two or more coats applied @ 6.5kg/10 sqm over and including priming coat of exterior primer applied @ 2.20 kg/10 sqm). High Quality Exterior Acrylic Modified resin and special quality Silica Quartz with Trowel Texture.</p> <p>The exterior paint colour shade shall be combination of RAL 2001 / RAL 1028 / RAL 1013.</p>	
	<p>4.11.00 Doors, Windows& Structural Glazing:</p>	
	<p>4.11.01 Doors, windows and ventilators of air-conditioned areas, entrance lobby of all buildings (wherever provided), and all windows and ventilators of all buildings (unless otherwise mentioned) shall have aluminium framework with glazing. The aluminium sections shall confirm to IS 733 & IS 1285 and shall have minimum 2 mm thickness. The aluminium frame shall be electro colour dyed (anodised with 15 micron coating thickness) when used on outer side of the building and it shall be powder coated(50 microns coating thickness) when used in interior of the building. All doors of toilet areas shall be of steel framed solid core flush shutter. For Mill Bunker Building, transfer points, crusher house, conveyor gallery, steel louvered windows shall be provided.</p>	
	<p>4.11.02 Control Rooms of all buildings shall be provided with Aluminium Glazed door.</p>	
	<p>4.11.03 Single glazed panels with aluminium framework shall be provided as partition between two air-conditioned areas wherever clear view is necessary.</p>	
4.11.04	<p>a) The doors frames shall be fabricated from 1.6 mm thick MS sheets and shall meet the general requirements of IS: 4351.</p> <p>b) All steel doors shall consist of double plate flush door shutters. The door shutter shall be 35 mm (min.) thick with two outer sheets of 1.2 mm rigidly connected with continuous vertical 1.0 mm stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 1.2 mm. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, locks etc.</p>	
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4.11.05	Steel windows and ventilators shall be as per IS: 1361 and IS: 1038.			
4.11.06	Wherever functionally required Rolling shutter (fully closed/partly grilled) with suitable operating arrangement (manual/Electric) shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS: 6248. M.S sliding doors with suitable mechanical and electrical operations fixtures as per requirement for bigger openings shall be used.			
4.11.07	All windows and ventilators on ground floor of all buildings shall be provided with suitable Aluminium grill.			
4.11.08	Fire-Proof doors with panic devices shall be provided at all fire exit points as per requirements. These doors shall be as per IS 3614. Fire rating of the doors shall be of minimum 2 hours of integrity and 30 minutes of insulation.			
4.11.09	Hollow extruded section of minimum 2 mm wall thickness as per IS: 1285 (Grade of Alluminum shall be Alloy 63400) shall be used for all aluminium doors, windows and ventilators.			
4.11.10	Minimum size of door provided shall be 2.1 m high and 1.2 m wide. However, for toilets minimum width shall be 0.75 m and office areas minimum width shall be 1.20m.			
4.11.11	<p>Electrically operated, self- operable/closing, aluminium framed with tinted glass, sliding doors shall be provided at the entrance of all common control rooms, entrance lobby of facility building. The sliding door (except in MPH) shall have 10mm thick toughened tinted glass in suitable Aluminium frame.</p> <p>At the entrance of all common control rooms in MPH G.I. framed with fire resistant glass, sliding doors shall be provided.</p> <p>The other doors in common control rooms in MPH shall be G.I. framed with fire resistant glass as per fire zoning.</p> <p>Fire Resistant Glazed Door System (Swing / Sliding) shall be of uniform GI profile 50X50 mm with 14mm EI 20 GLASS for Interior Application.</p> <p>Fire Resistant Glazed Door System shall have 120 minutes of integrity and radiation control (EW 120) with symmetrical (Bi-Directional) fire protection. The frames shall be cold rolled profiles as per EN standard EN 10327/ Indian Standard IS 513. The door frames are cold rolled from 1.5 mm steel sheet to form a profile of 50 mm x 50 mm on all sides. The door shutter shall have the top rail, side rail and bottom rail dimensions of 50 mm x 50 mm. The overall door opening shall be as per tested evidence and tested as per EN 1634-1/ ISO 834-1 / ISO 3009 /(Indian Standard) IS 16947:2018 in an accredited laboratory.</p> <p>The glass must be minimum 10 mm clear (MADE IN INDIA)120 min fire rated for Integrity, Radiation control (EW 120) and partially insulation (EI 20) Non Wired Toughened Interlayered glass with a light transmission of 86% and a sound reduction of 38 dB and manufactured in UL & TUV audited Facility and including UL-EU Certification and compliant to class 1(B)1 category of Impact Resistance as per EN 12600. The glass shall be tested and certified for no formation of bubbles or yellowing after 5000 hours of exposure to UV radiation by TUV Rheinf and as per EN 12543-4. The base glass and finished glass must made in India.</p> <p>The shutters shall be fixed to the frame using Weld-on hinges of dimensions 179mm X 20mm. The profiles shall have groves to incorporate Fire Resistant gaskets. The glass shall be held in its place with the help of 1.5 mm cold rolled steel beading and ceramic tape with cross section of 4 x 15 mm as per the test evidence. Beading shall be clipped on using</p>			
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	<p>Stainless Steel self-tapping screws fixed at a distance of 70 mm from the edges and 150 mm c/c henceforth. The glass panes are to be supported on non-combustible 6 mm Calcium Silicate setting blocks. The door shall be fitted with offset pull handle and door closer. The inactive leaf (in case of double leaf only)shall be fixed to the frame using a tower bolt at meeting edge at top or as per the tested evidence. The doors shall be manufactured in a TUV audited facility. The maximum glazing size shall be as per the test certification. The profile has to be fixed to the supporting construction by means of M10 or bigger steel bolts at every 150 mm from the edges and every 500 mm (approx.) c/c. The doors shall offer C4 level of wind resistance when tested as per EN12211 and shall provide class 4 level of air permeability as per EN 1026. The door shall also be subjected to durability tests as per EN 12400 for C5 classification (200,000 cycles). The doors shall also be tested for class 5 of impact resistance when tested as per EN 13049. The doors & partition shall also be tested for class 4 level of Mechanical strength when tested as per EN13115. The door shall have water tightness level of 8A when tested as per EN 1027.</p> <p>The sliding door system shall be connected to the surrounding construction by means of interlocking labyrinths lined with intumescent tapes as per the test evidence and connected to the sliding mechanism at the top. The sliding mechanism shall be as mentioned in the tested evidence or Assessment and shall have steel rollers. The glass should be held in its place with the help of 1.5 mm cold rolled steel beading and ceramic tape with cross section of 4 x 15 mm as per the test evidence. Beading shall be clipped on using Stainless Steel self-tapping screws fixed at a distance of 70 mm from the edges and 150 mm c/c henceforth. The glass panes are to be supported on non-combustible 6 mm Calcium Silicate setting blocks.</p> <p>The sliding mechanism shall be fixed to adequate supporting construction (MS channel / Reinforced concrete) to ensure proper support for the door.</p>			
4.11.12	Minimum area of windows in building on each floor level shall be 10% of floor area.			
4.12.00	Glazing			
4.12.01	All windows and ventilators (not specified elsewhere) shall be provided with minimum 6 mm thick toughened glass conforming to IS: 5437.			
4.12.02	For single glazed aluminium partitions and doors, 8mm thick clear toughened glass shall be used.			
4.12.03	Toughened tinted glass of 6 mm thickness shall be used for all windows and ventilators in toilets.			
4.12.04	All glazing work shall conform to IS: 1083 and IS: 3548.			
4.12.05	For glazings of Air Conditioned Buildings Composite double glazing shall be 24mm thick consisting of 6mm thick clear float glass on inner side and 6mm thick reflective toughened glass on outer side. The two glasses shall be separated by 12mm air-gap and hermetically sealed by beading of anodized aluminium with outer edge sealed with silicon sealant. Outer glass of 6mm thickness shall have following technical characteristics: Solar factor 25% or less, Maximum U-value 3.3 W/ SQMK, VLT min 30%: Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28)			
	The glass should be free from distortion and thermal stress			
4.12.06	For internal glazed partition, 8mm thick clear toughened glass shall be provided. Internal Glazed partition in in MPH shall be fully glazed fire rated fixed partition with 120 minutes of			
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	<p>integrity and radiation control (EW 120) with symmetrical (Bi-Directional) fire protection. The frames shall be cold rolled profiles As per EN standard EN 10327/Indian Standard (IS 513) . The frames are cold rolled from 1.5 mm steel sheet to form a profile of 50 mm x 50 mm on all sides. He system shall be tested as per EN 1364-1/(Indian Standards) IS 16945:2018 in an accredited laboratory.</p> <p>The glass shall be minimum 14mm thick clear 120 min fire rated for Integrity, Radiation control (EW 120) and partially insulation (EI 20) Non Wired Toughened Interlayered glass with a light transmission of 86% and a sound reduction of 38 Db and manufactured in UL & TUV audited Facility and including UL-EU Certification and compliant to class 1(B)1 category of Impact Resistance as per EN 12600. The glass shall be tested and certified for no formation of bubbles or yellowing after 5000 hours of exposure to UV radiation by TUV Rhein land as per EN 12543-4 The glass shall provide bi-directional (Symmetrical) fire protection. The base glass and processed glass must be made in INDIA.</p> <p>The glass shall be held in its place with the help of 1.5 mm cold rolled steel beading and ceramic tape with cross section of 4 x 15 mm as per the test evidence. Beading shall be clipped on using Stainless Steel self-tapping screws fixed at a distance of 70 mm from the edges and 150 mm c/c henceforth. The glass panes are to be supported on non-combustible 5 mm Calcium Silicate setting blocks. The maximum glazing size shall be as per the test certification. The profile has to be fixed to the supporting construction by means of M10 or bigger steel bolts at every 150 mm from the edges and every 500 mm c/c.</p> <p>The Partitions shall offer C4 level of wind resistance when tested as per EN12211 and shall provide class 4 level of air permeability as per EN 1026. The Partitions shall also be tested for class 5 of impact resistance when tested as per EN 13049. The Partitions shall also be tested for class 4 level of Mechanical strength when tested as per EN13115. The Partitions shall have water tightness level of 8A when tested as per EN 1027.</p>			
4.12.07	11.5 mm thick laminated glass consisting of 5 mm thick heat reflective toughened glass (cool-lite / Azure/ equivalent) on outer face and 5 mm thick toughened glass on inner face having 1.52mm PVB layer in between to be used for Structural glazing.11.5 mm Laminated glass with 6mm heat strengthened glass + 1.52mm PVB layer + 6 mm heat strengthened glass of approved make to be used in railings wherever shown in drawings.			
4.12.08	<u>Deleted</u>			
4.13.00	False ceiling			
4.13.01	False ceiling of 12.5 mm thick tapered/square edge glass fibre reinforced gypsum board conforming to IS : 2095 having fine texture finish, including providing and fixing of frame work at all levels, for all kind of work, consisting of light weight galvanised steel member (minimum 0.8 mm thick and galvanised as per IS: 277) having maximum grid size of 1200 mm x 600 mm for supporting panels of specified size, suspended from RCC structural steel or catwalkway grid above, with 4 mm (minimum) galvanised wires (rods), with special height adjustment clips, providing angle section of minimum 25 mm width along the perimeter of ceiling, supporting grid system (minimum 0.8 mm thick and galvanised as per IS: 277), expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (concealed grid and finished flat seamless and curve shape (dome etc.), finished smooth(seamless) along with the galvanised light gauge steel supporting system laid in profile to suit the profile of dome).			
4.13.02	False ceiling of 12 mm thk calcium silicate board with suspension system as per manufacturers details including supporting grid system, expansion fasteners for suspension			
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	arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (With concealed grid and finished flat seamless).			
4.13.03	Aluminium False Ceiling: Aluminium false ceiling shall be in 600 mm x 600 mm tile or plank type of 0.6 mm thickness (minimum)with perforation of 2.5 mm dia in combination with built in nonwoven tissue for providing good acoustic properties. False ceiling shall have coil coating of thickness 25micron (minimum) and it shall be installed with T-Grid (of profile 24 mm) in same or contrasting colours or with 6 mm recess joints. The whole system shall be level adjusting arrangement and shall be suspended as per manufacturer guidelines.			
4.13.04	Batten ceiling: Batten ceiling made up of extruded aluminum / metal of minimum 0.6mm thickness with powder coated finish (min. 40 microns) /wooden finish (minimum 0.11mm). The ceiling must have superior acoustics and must adhere to the highest health and safety standards. The battens shall have possibility of curvilinear arrangement. The batten ceiling shall be Green guard, tested/certified from UL/Intertek. The product shall meet technical requirements of ASTM E84. Batten ceiling of 1"x1" made up of extruded aluminum with "click-on system". Sublimation/Heat transfer method should not be used for better scratch resistance. Die-casted click on joinery shall not be used.			
4.13.05	Designer membrane ceiling: The ceiling shall have demountable translucent stretch ceiling membrane with harpoon, corners ready to install. It shall not get discoloured& sag. All joints shall be provided with appropriate interface trims to be able to demount the ceiling to access the lights. The ceiling shall be installed using ceiling aluminium suspension system, complete as per manufacturer's installation guidelines and as per approved shop drawings in line with the design intent and approval by Engineer In-charge. LED strips shall be installed using custom aluminium extrusions to ensure longevity of the installation. The ceiling shall have following features and properties: - Durable: The systems shall resist shocks and shall not crack with movement or under stretch conditions. Safe: The membranes and profiles shall have passed the stringent fire and safety tests. The membrane shall have been classified as non-toxic upon burning. The Flexible membrane shall be b-s1-d0 / ASTM E-84 class A tested/certified. Green: Membranes shall be 100% recyclable. There shall not be any welding defect on Membranes.			
4.13.06	Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc.			
4.13.07	Suitable M.S. channel (Minimum MC75 with maximum spacing of 1.2 m C/C both ways) grid shall be provided above the false ceiling level for movement of personnel and to facilitate maintenance of lighting fixtures, AC ducts etc.			
4.13.08	Underdeck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned area depending upon the functional requirements. This underdeck insulation shall consist of 50mm thick mineral wool insulation with 0.05 mm thick aluminium foil & 0.6 mm x 25mm mesh wire netting and shall be fixed to the ceiling with 2 mm wire ties.			
4.13.09	Suitable cut-outs shall be provided in false ceiling to facilitate fixing of lighting fixtures, AC grills, smoke detectors, etc.			
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4.14.00	Elevator Machine Room			
	<p>Elevator machine room shall be as per NBC requirements in either way. Elevator Machine room in all buildings shall be made as per option a) as stated below,</p> <p>a) Floor of the elevator machine room shall be of RCC and wall shall be of one brick thick masonry wall. It shall be provided with fire door and other requirements as per NBC and elevator norms. Roof of Machine Room shall be of RCC in case of RCC building and provided with Prefabricated Insulated Metal Sandwich panels in case of Structural Steel Building. (or)</p> <p>b) Floor of elevator Machine Room shall be provided with profiled metal decking sheet. Trough shall be filled with Insulating Material (glass wool or rock wool) and thereafter finished with Minimum 50 mm thick wooden flooring, consisting of 37 mm thick hardwood planks, finished with 11mm thick laminated wooden flooring with plank size 193x1195mm (material class shall be 34 as per EN13329), over 2 mm expanded polystyrene foam and polythene sheet under laying. Alternately, floor of the elevator machine room shall be of RCC with profiled metal decking sheet. Roof and Side enclosure of Machine Room shall be provided with Prefabricated Insulated Metal Sandwich panels.</p> <p>Doors of Machine Room shall be Double Plate Steel flush doors of thickness 45 mm with steel sheets of 18 gauge with necessary stiffeners. Space between two sheets shall be filled with mineral wool insulation. Frame of doors shall be pressed steel sheets of 16 gauge. All necessary fittings for the doors shall be provided by the Bidder. Rubber sealing, for making the Doors airtight shall also be provided.</p> <p>Windows/ventilators shall be of standard extruded anodised Aluminium Sections of minimum 2 mm thickness with 24 mm hermitically sealed double glazing consisting of two 6 mm thick toughened glass separated by 12 mm. gap.</p> <p>Technical requirements of prefabricated insulated metal sandwich panels/decking sheets shall be same as given elsewhere in this specification.</p>			
4.15.00	Interior Design			
	<p>A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working environment. It shall take into account the multidisciplinary engineering activities involving power plant technology, and architectural & civil engineering for a smooth control hierarchy and man machine interface. All the design aspects such as flooring, false ceiling, furniture, colour scheme equipment design & layout, illumination, firefighting, acoustics and ergonomics requirements shall be detailed out so as to present an overall unified aesthetic spatial appearance.</p> <p>The areas to be undertaken for this interior design process shall be control room complex including common control room, computer room, conference rooms and office areas in the buildings and the following aspects shall be reviewed and evaluated for design. Furniture to be supplied by Bidder for the control room complex and other control rooms shall be as specified under C&I specification.</p> <p>a) Layout, keeping in view the man-machine interface and suitable ergonomic practices.</p> <p>b) Integration of civil engineering with architecture and interior design.</p> <p>c) Illumination levels, noise levels, electromagnetic interference levels, taking into account the equipment and furniture.</p>			
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4.16.00	d) Comfort and safety requirements such as air conditioning, firefighting, fire escapes, etc.			
	e) Microprocessors based control system to control the functional requirements.			
4.17.00	The above design philosophy put into practice shall be detailed out through presentation drawings, perspective views, scale models, detail drawings, etc.			
	<div>Deleted</div> <div>Finishing Schedule</div> <div>Interior and Exterior Finishes shall be as given in Tables-A&B respectively attached at the end of these specification.</div>			
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	TABLE –A				
	INTERIOR FINISHING SCHEDULE				
	SL. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	1.	Main power house Building, MPH / CCR			
	a)	Unloading Bay, Balance area including passage, Cable vault, Equipment Area, SWGR/ ACP Room/ UAF Room, Switchgear room, MCC Room	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	b)	SWAS Room, UPS Battery charger room	Matt Finished Vitrified ceramic tiles.	Aluminium composite panel cladding on walls and columns upto false ceiling level	Aluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	c)	Operating Floor	20 mm thick heavy duty anti skid full body vitrified tile	Colour coated Metal cladding on A-Row& Gable end, up to crane girder level.	Metal deck roofing (bottom of sheeting with RAL 9002 finish)
	d)	General circulation and movement areas	20 mm thick heavy duty anti-skid full body vitrified tile		Acrylic distemper (except metal deck area).
	e)	Control room area including control room	Matt Finish Vitrified ceramic tiles flooring	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Metal Batten panel cladding for columns and walls	Metal Batten panel ceiling in combination with demountable translucent stretch ceiling membrane or as per approved design.
f)	control equipment room,	Matt finish Vitrified ceramic tiles.	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	Aluminium false ceiling (Plank Type) in combination with GRG plaster board border in column depth or as per approved design	
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	TABLE –A				
	INTERIOR FINISHING SCHEDULE				
	SL. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
		g) Conference room, senior executive room., Computer Room	Matt finish Vitrified ceramic tiles	Partition in fire rated glass with fire rated frames with 2 hr fire rating &Aluminium composite panel cladding for columns and walls	Aluminium false ceiling (Plank type) in combination with GRG plaster board border in column depth or as per approved design
		h) Record room	ceramic tiles	Acrylic distemper.	Aluminum false ceiling in combination with GRG plaster board border in column depth or as per approved design
		i) Locker room	Ceramic Tiles	Acrylic Emulsion Paint	Aluminum false ceiling in combination with GRG plaster board border in column depth or as per approved design
		j) Toilet area	ceramic tiles	Digitally glazed ceramic wall tiles up to False Ceiling Height	Calcium Silicate False Ceiling
		k) Office Room, Staff Room	Matt Finished Vitrified ceramic tiles.	Partition in fire rated glass with fire rated frames with 2 hr fire rating &Aluminium composite panel cladding for columns and walls	Aluminum false ceiling in combination with GRG plaster board border in column depth or as per approved design
		l) Laboratory area	Vitrified Ceramic / Acid/alkali resistant tiles.	Designer ceramic wall tiles up to False Ceiling Height/ Aluminium composite panel cladding for columns and walls in case of A.C Panel	Aluminum false ceiling in combination with GRG plaster board border in column depth or as per approved design
		m) RCC Stair case	18mm thick Granite (Polished and honed Finished) stone	Polished Granite Stone up to 1.2m. ht. & Acrylic Distemper Paint over wall putty finish for balance height.	Acrylic Distemper
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	TABLE –A				
	INTERIOR FINISHING SCHEDULE				
	SL. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
		n) Lift and Staircase Lobby	18mm thick polished granite stone as pattern.	18mm thick polished granite & glass mosaic tile cladding up to False Ceiling Height	Aluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
		o) Passages and general circulation areas.	Deleted	Deleted	Deleted
		p) Battery Room	Acid and alkali resistant tile.	Acid and alkali resistant tile up to 1.2m height and chemical resistant paint for balance height	Chemical Resistant paint except in locations where Metal deck has been provided
		q) Oil canal, oil room, oil purification Tank and other areas where oil spillage is likely to occur.	75 mm thick A.R. Brick	12 mm thick A.R. Tile	As above except oil canal.
		r) Pathways including roof area.	22mm thick concrete chequered tiles.	-	-
	2.	Deleted			
	3.	Deleted			
	4.	DELETED			
	5.	Sheds for Construction workers and O&M Workers			
		Rest room	Cement concrete with Metallic hardener topping. Matt Finished Vitrified Ceramic Tiles	Acrylic distemper	Metal roof


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	TABLE –A				
	INTERIOR FINISHING SCHEDULE				
	SL. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
		Toilets	Ceramic tiles.	Digitally glazed ceramic wall tiles dado up to false ceiling level.	Metal roof
	6.	Miscellaneous Switchgear room, control room/ Any other Building.			
		Operating/Maintenance areas/ MCC room /Switchgear Room	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
		Control room/RIO Room /PLC /Office area.	Matt Finished Vitrified Ceramic Tiles	Acrylic emulsion paint.	Aluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
		Battery Room	Acid, Alkali resistant tile	Acid, Alkali resistant tile 1.2m height / chemical resistant paint above dado	Chemical resistant paint (except metal deck area)
		Toilet/Pantry area	ceramic tiles.	Digitally glazed ceramic wall tiles dado up to 2200 mm	Acrylic distemper
		RCC Stair case	18 mm thick Marble Stone with grooves	18 mm thick Marble Stone	Acrylic distemper
	7.	Car Parking			
		Covered Parking	Concrete Blocks	Acrylic distemper	Acrylic distemper
	8.	Parking Shed	Concrete Blocks		
	9.	Deleted			
	Note : 1. All wall above false ceiling shall be plastered. 2. The colour and pattern of finish shall be as per approved details.				
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	<div><div>3.</div><div>All materials shall be of reputed and established brand approved by Engineer-in-charge.</div></div> <div><div>4.</div><div>Wherever alternative materials are specified, the final selection rests with Engineer-in-charge.</div></div> <div><div>5.</div><div>This finishing schedule shall also be applicable to similar functional areas for all other buildings and facilities.</div></div> <div><div>6.</div><div>All the finishing materials shall be applied/provided as per manufacturer specification and guidelines under the supervision & guidelines of manufacturer.</div></div> <div><div>7.</div><div>All electrical conduits in buildings for Lighting, HVAC and services shall be concealed type. The laying work of electrical conduits shall be done before finishing works.</div></div> <div><div>8.</div><div>All Plumbing pipes shall be of concealed type. The laying work of plumbing pipes shall be done before finishing works.</div></div>			
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	<div>TABLE –B</div> <div>EXTERIOR FINISHES SCHEDULE</div> <table><tr><th>Sl. No.</th><th>DESCRIPTION OF AREA</th><th>WALL AND PROJECTIONS</th><th>SOFFIT OF PROJECTIONS</th></tr><tr><td>1.</td><td>Auxiliary building in steel framed structure.</td><td>Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface/ Aluminium Composite Panel Approved colour/ colour combination of colour coated metal cladding</td><td>Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface Approved colour/ colour combination of colour coated metal cladding</td></tr><tr><td>2.</td><td>Building with concrete frame work, etc.</td><td>Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface</td><td>Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface</td></tr><tr><td>3.</td><td>Steel Structure, trestles, etc.</td><td>As per corrosion protection clause in Design criteria and General Specifications chapter</td><td></td></tr></table> <div>NOTE : 1. The colour and pattern of finish shall be as finalized by Engineer. 2. All materials shall be of reputed and established brand approved by Engineer.</div>				Sl. No.	DESCRIPTION OF AREA	WALL AND PROJECTIONS	SOFFIT OF PROJECTIONS	1.	Auxiliary building in steel framed structure.	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface/ Aluminium Composite Panel Approved colour/ colour combination of colour coated metal cladding	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface Approved colour/ colour combination of colour coated metal cladding	2.	Building with concrete frame work, etc.	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface	3.	Steel Structure, trestles, etc.	As per corrosion protection clause in Design criteria and General Specifications chapter	
	Sl. No.	DESCRIPTION OF AREA	WALL AND PROJECTIONS	SOFFIT OF PROJECTIONS																
	1.	Auxiliary building in steel framed structure.	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface/ Aluminium Composite Panel Approved colour/ colour combination of colour coated metal cladding	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface Approved colour/ colour combination of colour coated metal cladding																
	2.	Building with concrete frame work, etc.	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Waterproof Cement Paint over plastered surface																
	3.	Steel Structure, trestles, etc.	As per corrosion protection clause in Design criteria and General Specifications chapter																	
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D-1-5				
5.00.00	SALIENT FEATURES & DESIGN CONCEPT			
	This section of specification covers salient features and design concepts of Civil, Structural works pertaining to Power Plant components as detailed below. For architectural works refer Chapter D-1-4.			
5.01.00	DELETED			
5.02.00	Main plant Buildings/Structures shall comprise of:			
	<div>a) Engine & Generating set Plant Building/Power Block Area</div> <div>b) Utility Building</div> <div>c) Air Compressor Building</div> <div>d) Main Electrical Building</div> <div>e) Pipe & Cable Gallery</div>			
	Engine & Generating set Plant Building, Pipe cable Galleries & trestles shall have structural steel framed super structure.			
	All other buildings may have either RCC or structural steel framework.			
	Brief description of the above mentioned Main Plant Buildings is furnished herein:			
5.02.01	DELETED			
5.02.02	DELETED			
5.02.03	Machine Foundations in Main Plant Area			
	A. BLOCK TYPE			
	i. Salient Features			
	The scope of work of the Bidder shall be design and construction of all Civil & Structural Works of Machine Foundations including supply of all materials.			
	Block foundations:			
	Machine foundations shall be RCC block foundation directly resting on virgin soil/ pile below Ground level. The vertical faces of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board sandwiched between the vertical face of block foundation and minimum 230mm thick brick wall all round.			
	ii. Design Concept:			
	<div>a) For the machine foundations, detailed static and dynamic analysis shall be done.</div> <div>b) Wherever block foundation is adopted by the bidder, suitable provisions to be ensured by the bidder in their General Arrangement and design to prevent transmission of</div>			
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	<p>vibration from these machine foundations to other nearby structures / foundations.</p> <p>c) The bidder or his consultant should have adequate prior experience in design of machine foundations and the machines should be in successful operation for at least one year prior to the date of submission of bid.</p> <p>B. FRAMED TYPE</p> <p>i. Salient Features</p> <p>The scope of work of the Bidder shall be design and construction of all Civil & Structural Works of Machine Foundations including supply of all materials, springs & viscous dampers.</p> <p>Framed foundation:</p> <p>Alternative-1</p> <p>The framed foundation shall comprise of RCC top deck supported on steel helical springs & viscous dampers (called herein as the Vibration Isolation System – VIS). The general arrangement & details of springs/ viscous dampers and supporting group of columns and beams shall be based on Equipment detail of the Bidder.</p> <p>Alternative-2</p> <p>The framed foundation shall be conventional machine foundations comprising of RCC top deck directly supported on substructure comprising of columns and beams without any steel helical springs and viscous dampers. The columns shall be rigidly connected to the RCC deck at top and shall rest on open / pile supported foundation at bottom. The entire foundation system (including deck, columns and raft) shall be isolated from the adjacent building structural system and no connection between the adjacent structure and this framed foundation is permitted.</p> <p>Bidder has the option to choose either Alternative -1 or Alternative-2 based on his design philosophy and practice.</p> <p>ii. Design Concept:</p> <p>a) For the framed foundations, detailed static and dynamic analysis shall be done.</p> <p>b) The vibration isolation system (wherever applicable) supplied shall be of proven make and shall be in successful operation.</p> <p>c) Wherever alternative-2 is adopted by the bidder, suitable provisions to be ensured by the bidder in their General Arrangement and design to prevent transmission of vibration from these machine foundations to other nearby structures / foundations.</p> <p>d) The bidder or his consultant should have adequate prior experience in design of machine foundations for the respective alternative to be adopted by the bidder and the machines should be in successful operation for at least one year prior to the date of submission of bid.</p> <p>For detailed specification of steel helical springs and viscous dampers refer General Specification Chapter.</p>		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.02.04	DELETED			
5.02.05	DELETED			
5.02.06	DELETED			
5.02.07	DELETED			
5.02.08	<p>Pipe & Cable Galleries</p> <p>i.Salient Features</p> <p>The Pipe- Cable Gallery shall be Structural Steel Superstructure with Steel Truss (Lattice Girder) having a general span of 15.0m/20.0m. The steel truss shall be supported on 2 legged/ 4 legged trestles the arrangement of which shall be developed by the Bidder. Trestles for pipe and cable galleries shall also be of structural steel.</p> <p>The width of the Gallery shall vary depending on the functional requirement. A walkway of minimum width 600mm shall be provided along the Cable Trays supporting floor of the gallery. The walkway shall comprise 40mm thick galvanized MS grating and 1.0m high handrail made of 32NB MS pipes. For pipe cable galleries carrying ash pipes, galvanized MS grating shall be provided over entire width of the gallery with handrails.</p> <p>Plan bracings shall be provided at all chord levels of the cable gallery truss. Minimum gusset plate thickness shall be 8mm for all connections.</p> <p>The level of the bottom chord (bottom of steel) of the gallery shall be at least 3.0m above the finished paving level in general. However, at all road/rail crossings, the level of bottom of steel of the gallery shall be at least 8.0m from the top of road surface and 8.5 m from top of rail track.</p> <p>The Caged structural steel ladder shall be provided at an interval of 100m for access to the Pipe-Cable Gallery Walkway.</p> <p>At the inter-connection of Pipe/Cable gallery with Plant buildings, Pipe/Cable gallery shall be terminated at a maximum distance of 1.50m from the building. The foundation of the Pipe/Cable Trestle shall be constructed at a distance of 4.0M from edge of the plant building. Cantilever of 2.50m shall be taken from pipe-cable gallery/ trestle structure.</p> <p>The foundation for Pipe-Cable gallery trestles shall be open foundation or pile foundation depending upon bearing capacity requirements. For specification regarding open and pile foundations, clause. 3.00.00 is to be referred. The grade of concrete for RCC footing/pilecaps & pedestals shall be M40. The structural trestles shall not be supported on paving RCC slab.</p> <p>ii. Design Concept</p> <p>The pipe-cable structure shall be designed as a 3-dimensional space frame for all the relevant load cases mentioned in the design criteria chapter.</p> <p>The gallery being an unclad building, wind load shall be evaluated based on the projected frontal area of the structural members and cable tray depth.</p> <p>The end portals shall be designed as rigid frames hinged (pinned support) at the base plate level (on top of the trestle column). Deflection of end portal due to wind shall be evaluated at the portal column-rafter joint. The gallery vertical truss shall be designed as simply supported girders on trestles and detailing of end portals shall be done accordingly.</p>			
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5.02.09	<p>Suitable expansion gap shall be provided in the gallery structure by providing twin two-legged trestles at the expansion gap. The expansion gap shall be provided at an interval of 100 to 120m. Expansion gap shall also be provided at location where changes in plan dimensions (gallery width) take place abruptly.</p> <p>Engine & Generating set Plant Building/Power Block Area</p> <p>This engine building is designed to accommodate the Gas Engine, Generator Set and associated ancillary equipment. The structure is a steel-framed facility, preferably constructed as a Pre-Engineered Building (PEB). The power block area includes the following components:</p> <p>(a) Foundations for Engine and Generator Sets – 9x12MW (110.56x23) & 24x4.5MW (139.13x21.84-2) (b) Engine Auxiliary Modules (c) Exhaust Gas Handling Area</p> <p>Roofing System</p> <p>The building roof shall consist of an industrial grade, steel standing seam Galvalume sheet, mounted on steel purlins. Both the interior and exterior surfaces will feature the manufacturer’s standard protective colour coating. Acoustic treatment will be incorporated into the roof design to comply with plant noise level requirements. The roof shall be accessible for maintenance activities. For painting structures, corrosive category CX as per IS For structural steel works, the item for high performance painting as per Corrosivity Category CX and very high durability to be included</p> <p>Wall System</p> <p>A 3.0 m-meter-high brick will be constructed from the Finished Floor Level (FFL) upward and RCC sunshade for doors & windows. Above this, the building walls will consist of an industrial-grade, steel standing seam Galvalume sheet, fixed to steel girts supported by the main structure.</p> <p>Cranes and Handling Equipment</p> <p>The building will be equipped with an Electric Overhead Traveling (EOT) Crane, designated for handling heavy equipment within the facility</p> <p style="text-align: center;">Main Electrical Building</p> <p>This shall be Reinforced Cement Concrete (RCC) framed structure with cast in situ RCC roof and the wall cladding shall be in brick work Flooring and other finishing works shall confirm to the specified requirements.</p> <p>Air compressor building</p> <p>This shall be Reinforced Cement Concrete (RCC) framed structure with cast in situ RCC roof and the wall cladding shall be in brick work Flooring and other finishing works shall confirm to the specified requirements.</p>			
5.02.10	DELETED			
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5.02.11	All Civil, Structural and Architectural Works associated with Water Treatment System, Service Water System, Chemical Treatment System, Effluent Treatment System Civil Works, etc.			
5.02.11.01	Design Concepts for Buildings/ Shed			
	<div>i. All Buildings shall have RCC framed structure with cast-in-situ RCC roof slabs with brick cladding.</div> <div>ii. Equipment/facilities with shed shall have structural steel superstructure with permanently colour coated metal sheeting at roof and side open. However, kerb wall shall be provided all around the plinth/ floor area above the Finished Floor Level (FFL). For other buildings brick wall cladding on exterior face shall be provided.</div> <div>iii. Unless specified, the wall cladding for buildings shall be with minimum one brick thick on exterior face. However, brick wall for buildings adjacent to transformers shall be minimum 345mm thick.</div>			
5.02.11.01.01	Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.			
5.02.11.01.02	The load and load combinations and design criteria shall be as specified elsewhere in the specification.			
5.02.11.01.03	<div>All liquid retaining structures shall be designed for following load conditions.</div> <div>Underground structures:</div> <div><div>a. Water filled inside up to design level and no earth outside.</div><div>b. Earth pressure with surcharge of 2.0 T/m2 and ground water table up to FGL outside and no water inside.</div><div>c. Stability against uplift shall be checked for completed structure and under construction stage with no water inside and ground water table up to FGL, with a minimum factor of safety of 1.20 against uplift. Installation of pressure relief valves shall not be permitted in the base slab of any liquid retaining / conveying structure.</div><div>d. The structure shall also be checked for normal working condition with water filled inside up to design level and earth pressure outside with no effect of surcharge and ground water table.</div></div> <div>For design of overground liquid retaining structures appropriate load cases shall be considered.</div>			
5.02.11.01.04	<div>All liquid retaining and conveying structures shall be designed as per IS 3370(Part2).</div> <div>In the wall of liquid retaining structures with cylindrical shape such as clarifiers, vertical reinforcement shall be checked assuming the walls were fully fixed at the base, and the horizontal reinforcement shall be provided to resist horizontal (hoop) tension assuming hinged condition at the junction of the base slab & wall.</div> <div>Wherever sandwich slabs are provided in liquid retaining structures to take care of stability against uplift, only well graded sand shall be used as fill material. The sand compaction shall be done with plate / disc compactors in such a manner that the bottom slab is not structurally damaged.</div>			
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5.02.11.01.05	<p>Clear free board of at least 300 mm above design (total) water level shall be provided in all liquid retaining / conveying structures.</p> <p>Coefficient of active earth pressure shall be considered for design of free standing retaining walls and coefficient of earth pressure at rest shall be considered for design of top propped retaining walls.</p> <p>The minimum grade of concrete for all RCC structures shall be M30. The minimum concrete clear cover to reinforcement bars in all RCC structures shall be as per IS:456(2000) and IS:3370(Part II) for water retaining structures. Durability of concrete shall conform to severe exposure conditions as per Table-3 of IS 456 except noted specifically otherwise.</p>																			
	<p>Factor of safety against overturning and sliding</p> <p>The structure shall be checked for minimum factor of safety of 1.5 against overturning conditions (ratio of stabilizing moment to overturning moment) and 1.4 against sliding conditions as per IS: 456.</p>																			
5.02.11.01.06	<p>For detailing of Reinforcement IS 5525, IS 13920, IS 4326 and SP 34 shall be followed.</p> <p>Two layers of reinforcement (on both faces) shall be provided for RCC sections having thickness of 150 mm and above.</p> <p>Minimum diameter of main and distribution Reinforcement bars in different structural elements shall be as follows:</p> <table><tr><th>Sl. No.</th><th>Structural Element</th><th>Main Reinforcement</th><th>Distribution Reinforcement / Stirrups/ ties/ Anchor Bars</th></tr><tr><td>a)</td><td>Foundation</td><td>12 mm</td><td>12 mm</td></tr><tr><td>b)</td><td>Beams</td><td>12 mm</td><td>8 mm</td></tr><tr><td>c)</td><td>Columns</td><td>12 mm</td><td>8mm</td></tr></table>				Sl. No.	Structural Element	Main Reinforcement	Distribution Reinforcement / Stirrups/ ties/ Anchor Bars	a)	Foundation	12 mm	12 mm	b)	Beams	12 mm	8 mm	c)	Columns	12 mm	8mm
	Sl. No.	Structural Element	Main Reinforcement	Distribution Reinforcement / Stirrups/ ties/ Anchor Bars																
a)	Foundation	12 mm	12 mm																	
b)	Beams	12 mm	8 mm																	
c)	Columns	12 mm	8mm																	
5.02.11.01.07	<p>Spacing of reinforcement bars in walls and slabs of liquid retaining / conveying structures shall not be more than 200 mm.</p> <p>Suitable shrinkage reinforcement shall be provided at top face of foundations. Minimum shrinkage reinforcement shall be 10 mm dia. @ 200mm c / c.</p> <p>Minimum Reinforcement in all elements of liquid retaining / conveying structures shall be 0.24 % of cross sectional area.</p> <p>Minimum tensile Reinforcement in each direction for all foundation slabs / rafts shall be 0.2% of cross sectional area.</p>																			
	<p>Minimum thickness of foundation slab / raft and base slab of all liquid retaining tanks / pits shall not be less than 250 mm.</p> <p>Minimum thickness of all other elements of RCC liquid retaining / conveying structures (except effluent drains) shall be 200mm. Effluent drains (depth more than 500mm), shall have minimum element thickness of 150mm.</p>																			
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5.02.11.01.08	<p>All Insert plates (except edge protection angles) provided in liquid retaining structures shall be 12 mm thick GI with lugs not less than 12 mm diameter rods or 6 mm flats.</p> <p>Edge protection angles shall be provided as specified elsewhere.</p>			
5.02.11.01.09	<p>All water retaining structures shall be tested for water tightness as per provisions of IS: 3370 and IS: 6494.</p>			
5.02.11.01.10	<p>For areas other than paved area, 2.0m wide walkway with M40 grade concrete paving over an under bed specified elsewhere shall be provided connecting all structures, buildings and facilities. The top of walkway shall be minimum 200mm above FGL Reinforcement of the RCC paving shall consist of minimum 8mm diameter bars @ 200 mm c / c in both directions at the centre of the slab.</p>			
5.02.11.02	<p>Coating on RCC water retaining structures (other than drinking water)</p> <p>Epoxy phenolic coating shall be applied on (i) internal surfaces of the RCC water retaining structures and (ii) external surfaces of RCC Neutralisation-pit which is in contact with earth, as per details specified below:</p> <p>a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 50 micron DFT. Surface to be coated shall be absolutely dry, clean and dust free.</p> <p>b) Sealer coat shall be followed with the application of epoxy phenolic coating (solid by volume minimum 63%) of minimum 400 micron DFT. This coat shall be applied after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.</p>			
5.02.11.03	<p>Coating on RCC water retaining structures (drinking water)</p> <p>Internal surfaces of RCC water retaining structures shall be provided with minimum 400 micron Food grade epoxy coating complying to FDA Title 21, Part 175.300. Surface to be coated shall be absolutely dry, clean and dust free.</p>			
5.02.11.04	DELETED			
5.02.11.05	<p>Acid / Alkali Resistant Treatment:</p> <p>Acid / alkali resistant lining treatment shall be provided in different areas as follows:</p> <p>Neutralization Pit: The walls shall be provided with one coat of bitumen primer, followed by 18 mm thick bitumastic layer, 115 mm thick Acid Resistant (A.R.) bricks, 6 mm thick under bed of potassium silicate mortar, pointing the joints of bricks with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing. Suitable pilasters shall be provided with A.R. bricks at regular intervals depending upon the height of lining, as per the specification.</p> <p>The floor of neutralization pit shall be provided with acid / alkali resistant lining treatment as given in the above para, except that the 115 mm thick A.R. bricks layer shall be replaced by 75 mm thick A.R. tile layer and pilasters shall be omitted.</p> <p>The ceiling of neutralization pit shall be provided with one coat of epoxy primer followed by 2 coats of epoxy paint (150 micron).</p> <p>Acid / Alkali storage area / projections above the floor, pedestals projecting from the floor / saddles. The floor shall be provided with one coat of bitumen primer followed by 12 mm thick</p>			
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5.02.11.06	<p>bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick under - bed by potassium silicate mortar, 6mm thick pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar up to a depth of 20 mm and bitumastic end sealing. Dado of 1.0M high with above treatment shall also be provided if applicable in case of walls nearby.</p> <p>The floor shall be provided with acid / alkali resistant lining treatment as given in the above para except that the 75 mm thick A.R. tile layer shall be replaced by 12 mm thick A.R. tile layer.</p> <p>Basket of Alum Solution Preparation tank: 5mm thick epoxy lining over a coat of epoxy primer.</p> <p>Curved surfaces of saddles shall have minimum 12 MM thick bitumastic layer to support the vessel / tanks.</p> <p>Effluent Drains: Acid Resistant lining treatment indicated for the storage area shall be provided on the bed as well as walls of the drains with 38 MM AR tiles. The underside of the pre-cast slab cover shall be applied with one coat of epoxy primer and two coats of epoxy coating, total DFT 150 microns.</p> <p>Lime tank: Two coats of bitumen paint conforming to IS: 9862, with total DFT 150 microns.</p> <p>Guarantee</p> <p>The Contractor shall give a guarantee for satisfactory functioning of the lining for a period of 36 months from the date of completion of the work or date of handing over the site to the Engineer, whichever is later.</p> <p>The Contractor shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.</p> <p>Foundation of Over Ground Steel Circular Water Storage Tanks</p> <p>General Requirements</p> <p>The tank foundation shall be as per IS 803 and as specified in relevant clause of foundation chapter.</p> <p>Sub Grade Preparation</p> <p>The surface of natural soil shall be thoroughly compacted by rolling or other means, as directed by Engineer, to obtain 95% of max. laboratory dry density for the soil, as per IS:2720 (Part-VII).</p> <p>Anti Corrosive Layer</p> <p>Anti-corrosive layer shall consist of screened coarse sand, mixed with VG30 grade bitumen in 8% to 10% by volume.</p> <p>Bitumen shall be heated to a temperature 175⁰C to 190⁰ C, with 3% kerosene, if required. Sand shall be thoroughly mixed with it in a mixing drum to obtain uniform mixture and shall be laid over the compacted surface, laid in line, grade and levels and as directed by the Engineer. Bitumen shall not be heated beyond the temperature limits given above.</p> <p>The premix carpet shall be laid in two layers of 3 cm and 2 cm respectively. After compacting and laying the first layer of 3cm, a tack coat of hot bitumen at the rate of 1 Kg. per Sq.m. shall</p>		
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5.02.11.07	<p>be uniformly applied to the surface, by means of Sprayer and the Second layer of 2cm thick shall be laid, tamped and compacted to the satisfaction of the Engineer.</p> <p>Sand shall be spread on the final surface at the rate of 0.5 Cu. m per 100Sq.m.</p> <p>Premix</p> <p>Materials</p> <p>Sand</p> <p>Sand shall be clean, dry, coarse, hard angular, free from coatings of clay, dust and mix of vegetable and organic matters and shall conform to IS 383 (Grade -III).</p> <p>Stone Chippings</p> <p>Stone chippings shall be hard black trap or granite or locally available stone and shall conform to IS 383. The grading shall be of normally 12mm down size and 6mm down size, in the ratio of 3:2 respectively.</p> <p>Bitumen</p> <p>Bitumen required for the work shall be VG30 grade or its equivalent quality.</p> <p>Laying</p> <p>Areas on which the premix is to be laid shall be thoroughly cleaned of all dust and loose materials. On the cleaned surface, a tack coat at the rate of 1.0 Kg. per Sq.M. of hot Bitumen shall be uniformly applied by Sprayers. The applied Binder shall be evenly brushed.</p> <p>The Binder bitumen 80/100 VG 30 shall be heated to the temperature of about 190⁰ C with 3% kerosene, if required and mixed with stone chippings of size, as mentioned above, at the rate of 400 KG, with Six (6) Cu. M. of stone chips, for 100 Sq.M. of surface. The total mixed quantity, as mentioned above, is the quantity required for the total 50mm thick for 100 Sq. m. of area. Mixing shall continue until the aggregate is well coated.</p>			
5.03.00	DELETED			
5.04.00	DELETED			
5.05.00	DELETED			
5.06.00	DELETED			
5.07.00	<p>SEWERAGE SYSTEM:</p> <p>Complete sewerage system upto nearest Sewage Treatment Plant for facilities is in bidder's scope.</p> <p>Cement concrete pipes of class NP-3 as per IS 458 shall be used below ground level for sewage disposal in all areas other than main plant area. However, for pressure pipes and in main plant areas, and under roads spun Cast Iron pipes conforming to IS 1536 of required class shall be used. RCC manholes with CI cover shall be provided at every 30m along the length, at connection points, and at every change of alignment, gradient or diameter of a sewer pipeline. This shall be as per IS 4111.</p> <p>Sewage pump stations shall be provided as per IS 4111.</p>			
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5.08.00	<p>Bidder shall have to provide complete arrangement for sewage disposal up to the sewage treatment plant including pumping facilities. Manual electrically operated control system shall be provided.</p>			
	<p>Plant Storm Water Drainage System</p> <p>Complete storm water drainage system is in bidder's scope. Storm water drain shall be designed taking into account the finished ground levels of the plant & surrounding area drainage pattern, intensity of rainfall, etc. with a return period of 50 years. These values shall be based on minimum rainfall intensity of 75mm/hr. All RCC drains shall be either RCC Cast-in-Situ or RCC Pre-cast drains. The minimum grade of concrete shall be M40 for RCC Cast-In-Situ drains and M40 for RCC Pre-cast drains. The maximum velocity for RCC open drains shall be limited to 1.8 metre per second. However, minimum velocity of 0.6 metre per second for self - cleansing shall be ensured. Bed slope not milder than 1 in 1000 shall be provided. The inside drain dimension at any point should not be less than 0.45m (height) x 0.75m (breadth). The runoff coefficient of paved and unpaved area shall be 0.9 and 0.6 respectively.</p> <p>Open RCC rectangular section, unless required otherwise due to functioned requirement, shall be provided for all drains. The thickness of side walls and bottom slab of RCC drains shall be minimum 150mm or as per design considerations whichever is higher for drains upto depth of 1m from formation level. For depth of drain more than 1m from formation level, the thickness of side walls and bottom slab of RCC drains shall be minimum 200mm or as per design considerations whichever is higher.</p> <p>The drains shall be provided on both sides of the double lane roads and single lane roads. The drains shall be provided on one side of the patrol roads along boundary wall. These shall be designed to drain the road surface as well as all the free and covered areas, etc. Box culverts shall be provided at all rail, road and other crossings.</p>			
	<p>Complete drainage upto outfall point to be completed to avoid flooding in the respective area. The design of drains and its layout to be developed meeting the recommendations of "Area Drainage Study" report.</p>			
5.09.00	<p>CIVIL WORKS IN TRANSFORMER YARD AREA</p> <p>All Civil and Structural works in Transformer yard area as shown in tender drawing including design, drawings and detailed engineering as per the following concept:</p>			
5.09.01	<p>TRANSFORMER FOUNDATIONS</p> <p>Foundations of transformers shall be designed for seismic and wind loads in addition to other applicable loads. Solid RCC block foundation shall be provided for the main transformer block. Alternatively, transformer shall be supported on a RCC foundation comprising of common raft for rail supporting walls up to rail-cum-road along with pedestals for jacking pad, roller lock etc. Tie beams connecting roller lock pedestals at rail level shall also be provided. Common raft/solid RCC block shall be supported on soil or pile based on requirement specified elsewhere in the specification.</p>			
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5.09.02	<p>RCC Firewalls shall be provided between the transformers as per technical requirement mentioned elsewhere in the specification.</p>			
	<p>OIL SOAK PITS & OIL WATER SEPARATION PIT</p> <p>Oil soak pit and oil water separation pit for transformer shall be provided as envisaged elsewhere in the specification.</p> <p>The oil soak pit shall be provided for each transformer and shall be filled with gravel of size 40mm. The volume of the soak pit shall be sufficient to store one-third (1/3) of the oil volume of transformer/reactor considering only 40% of the volume as available voids between gravel filling. The oil soak pit shall also be provided with a sump at the corner to allow drainage of water/oil from the soak pit. Oil soak pits sump of individual transformers shall be connected to common oil water separation pit through hume pipes and manholes.</p> <p>Separate common oil water separation pit shall be provided for a group of transformers in transformer yard area of each generation unit of plant.</p> <p>The Oil-water Separation pit shall be designed for an effective capacity of complete oil of one transformer having highest volume of oil along with 10 minutes of firewater. For calculating effective capacity of oil-water separation pit, effective depth excluding 200 mm freeboard below invert level of inlet pipe shall be considered. Plan area and depth of oil-water separation pit shall be decided based on above consideration.</p> <p>Oil-water Separation pit shall be provided with five separate chambers interconnected by pipes. First chamber shall be for collecting oil-water mix from transformers’ soak pits in case of fire. After entering into first chamber, oil being the lighter in density floats above the water. The water from lower elevation flows in to subsequent chambers interconnected through galvanized MS pipes. The accumulated oil in the first chamber to be pumped out for subsequent usage or disposal. Water collected in the last chamber to be pumped out for subsequent disposal after treatment. Invert level of inlet Hume pipes (of NP-3 grade and adequate capacity), carrying oil and water from transformers soak pits, shall be designed for gravity flow. Freeboard of 200 mm shall be provided below the invert level of inlet pipes. Invert levels of interconnecting pipes of subsequent chambers shall be decided accordingly.</p>			
5.09.03	<p>RAIL TRACK CUM ROAD</p> <p>Arrangement for moving the transformer into place using rail cum road, jacking pads and pulling blocks including inserts, as required, shall be provided along with the transformer/reactor foundations. This Rail track cum road shall enable movement of all transformers to all the unloading bays of Main Power House.</p> <p>Jacking points shall be provided at all the intersections of Rail Tracks with minimum 300mm x 300mm x 16mm thick MS Plates. Mooring posts shall be provided along centre line of Rail tracks at maximum interval of 15m spacing.</p>			
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5.09.04	<p>Rail track cum road shall consist of minimum 500mm thick RCC M40 base slab over an under bed as specified below. The under bed for base slab shall consist of 75mm thick PCC on stone soling of 230mm compacted thick with 63 mm and down aggregate with interstices filled with well graded selected sand/ moorum/ non-expansive soil on compacted and dressed sub - grade. Reinforcement for the slab shall consist of minimum 16mm diameter bars @ 200 mm c/c at bottom of the slab in both directions and minimum 12mm diameter bars @ 200 mm c/c at middle and top in both directions.</p> <p>The rails shall be 52 kg/m Industrial Use (IU) as per Indian Railway Specification IRS T-12.</p> <p>Width of Rail track cum road with three rails and two rails shall be 5.0M and 3.5M respectively.</p>			
	<p>BUS DUCT SUPPORT AND DG STACK SUPPORT FOUNDATIONS</p> <p>Foundations for Bus duct supports and DG Stack support shall be supported on soil or pile based on requirement specified elsewhere in the specification. For design concept and criteria, refer cl no 6.03.34.</p>			
	<p>DG SET FOUNDATIONS</p> <p>Block foundation shall be provided for DG Sets. Block foundation shall be RCC block foundation directly resting on virgin soil/ pile below Ground level. The vertical faces of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board sandwiched between the vertical face of block foundation and minimum 230mm thick brick wall all round. For design concept and criteria, refer cl no 6.03.17.</p>			
5.09.06	<p>ENCASEMENT OF PYLON SUPPORTS</p> <p>300 mm thick PCC M25 encasement all around the Pylon supports inside soak pit for firefighting system shall be provided up to top of gravel filling.</p>			
5.09.07	<p>FENCING AND GATES</p> <p>Fencing and Gates shall be provided in line with cl no 6.09.00.</p>			
5.10.00	<p>Roads</p> <p>All roads shall be of rigid pavements unless otherwise specified. Rigid pavements shall be constructed with either conventional cement concrete. Concrete road/pavement or rigid pavement, mentioned in specification, shall mean road /pavement constructed with either Cement Concrete (CC) or with Geopolymer Concrete. All concrete roads shall be unreinforced jointed plain concrete pavement having dowels in transverse joints and tie bars at longitudinal joints.</p> <p>A 40mm bitumen mastic wearing course over concrete pavement shall be provided with industrial bitumen of grade 85/25 conforming to IS : 702, prepared by using mastic cooker and laid to required level and slope, including providing antiskid surface with bitumen fine grained</p>			
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CLAUSE NO.	<div style="text-align: center;"> TECHNICAL REQUIREMENTS  </div>		
5.10.00.01	<p>hard stone chipping of approved size at the rate of 0.005 precoated cum per 10 sqm and at approximate spacing of 10 cm centre to centre in both directions, pressed into surface protruding 1 mm to 4 mm over mastic surface, including cleaning the surface, removal of debris etc. all complete. (Considering bitumen using 10.2% as per MORTH specification).</p> <p>This 40mm bitumen mastic wearing course shall be laid after completion of construction activities i.e at the time of handover. Before the laying of Bitumastic layer all the roads shall be repaired/made good as per IRC : SP :83.</p> <p>All the road shall again be repaired/made good as per IRC : SP :83 after completion of construction activities i.e at the time of handover. Before the laying of Bitumastic layer all the roads shall be repaired/made good as per IRC : SP :83.</p> <p>All service and utility lines like fire water line, sewerage line, electric cables line etc. crossing the road shall be taken through NP3 class RCC Hume pipe. Hume pipe shall be laid before road work so that the road shall not be damaged.</p> <p>Turning Circle radius adequate for 16 Wheel Truck shall be provided at all relevant points including approach (Entry/Exit) and access road for Truck movement at loading/unloading/weighment facilities of Limestone, Gypsum, Ash, Biomass for efficient and safe movement of truck.</p> <p>For road to be constructed Cement Concrete:-</p> <p>The design of rigid pavement shall be carried out as per IRC: 58. The effects of design wheel load, maximum tyre inflation pressures, tyre contact area for the vehicle, traffic loads, environmental factors such as temperature changes in the pavement, other factors, like impact, load repetitions, etc., are to be taken. The design traffic load shall be a minimum value of 4 million standard axles. The road shall be designed for 30 years of life and considering a minimum traffic growth rate of 1 per cent per annum. The concrete pavement for roads shall be minimum 250 mm thick slab.</p> <p>The road construction including its shoulders, base, sub base and concrete pavement shall be as per MORTH. The road base shall be with minimum 150 mm thick dry lean concrete over granular sub base. Dry lean concrete shall be laid by a mechanical paver and compacted by vibratory rollers. Concrete pavement of the road shall be done with fully mechanized paver fitted with electronic sensors for construction techniques. Laying /placing of Concrete DLC and PQC manually with hand-guided means or by semi-mechanized methods may be permitted around Engine area provided acceptance criteria as per MORT&H specification is achieved. Dry lean concrete shall be minimum M25 grade and concrete pavement slab shall be minimum M40 grade concrete pavement shall be provided with 125 micron polythene sheet below it. Concrete pavement shall also be provided with contraction and expansion joint with MS dowel bars and as per Ministry of Road Transport and Highways (MORTH) specification.</p> <p>The finished top (crest) of all roads shall be 350 mm above the surrounding finished ground level.</p>		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>All culverts and RCC bridges at crossings of all roads / rail tracks / facilities with drains / nallahs / channels / roads / rail tracks / pipes / other facilities, etc. are to be designed and constructed.</p> <p>Unless otherwise specified, all roads (excluding access roads to all buildings / facilities / structures, patrol road along boundary wall and road inside the switchyard) shall be double lane roads.</p>			
5.10.00.02	<p>Conventional Cement Concrete road shall be constructed over soil sub-grade/embankment. Road section shall comprise of Granular Sub base over soil sub-grade, Dry Lean Concrete of M25 Grade (DLC) base and Pavement Quality Concrete of M40 grade (PQC) top layer. Thickness of different layers of pavement section shall be as per design. However, minimum thickness shall be 150 mm for DLC and 250 mm for PQC. Provisions of Clause 5.10.00.01 in respect of design, construction and other requirement shall also be applicable for Geopolymer concrete road. In addition, specific information pertaining to geopolymer concrete is provided in Chapter D-1-6.</p>			
5.10.01	<p>DOUBLE LANE ROADS</p> <p>The double lane roads shall be (12 metre wide) with 7.5 metre wide concrete pavement and 2.25 metre wide raised shoulders on both sides of the roads as given in tender drawing “Details of road”.</p>			
5.10.02	<p>SINGLE LANE ROADS</p> <p>The single lane roads shall be (5.75 meter wide) with 3.75 meter wide concrete pavement and 1.0 meter wide flat shoulders on both sides of the road as given in tender drawing "Details of Road".</p> <p>All access roads to all buildings / facilities / structures, road approaches / connections, access roads to liquid fuel storage areas and other equipment areas where access is necessary from inspection, operation and maintenance point of view and all roads inside the switchyard shall be single lane roads as given in tender drawing “Details of road”.</p>			
5.10.03	<p>PATROL ROADS</p> <p>All patrol roads along the boundary wall shall be single lane roads with 3.75 metre wide concrete pavement and 1 metre wide shoulders on one side of the road as given in tender drawing “Details of road”.</p>			
5.10.04	<p>INTERMEDIATE ROAD:</p> <p>The intermediate lane roads shall be (8 meter wide) with 5.5 meter wide concrete pavement and 1.25 meter wide raised shoulders on both sides of the road as given in tender drawing Details of Road.</p>			
5.11.00	DELETED			
5.12.00	DELETED			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.13.00	<p>AREA PAVING</p> <p>RCC paving of minimum 150 mm thick with M40 grade concrete, over an under bed as specified herein shall be provided for areas mentioned below. RCC paving shall be designed as rigid reinforced concrete pavement for the crane/ vehicular/ equipment movement loads which the paving has to bear. The under bed for paving shall consist of preparation and consolidation of sub-grade to the required level, laying of stone soling of 200mm compacted thickness for normal duty paving and 400mm compacted thickness for heavy duty paving with 63 mm and down aggregate with interstices filled with selected moorum/ non-expansive soil followed by 75 mm thick M25 PCC with 40 mm nominal size aggregate. For normal duty paving, reinforcement of the RCC paving shall consist of minimum 8mm diameter bars @ 200 mm c / c in both directions at the centre of the slab. For heavy duty paving/ passage, reinforcement of the RCC paving shall consist of minimum 10mm diameter bars @ 200 mm c / c in both directions at the centre of the slab.</p> <p>Paving areas shall be provided with the metallic hardener floor finish as specified elsewhere in the specification.</p> <p>Passages (7.5m wide minimum) shall be provided from outer periphery road to have access to the various facilities/buildings. These passage areas shall be provided with heavy duty paving for movement of heavy vehicles. The top surface of the passages shall be finished with 50 mm thick metallic hardener topping.</p> <p>All other areas around the buildings shall be provided with normal duty paving without metallic hardener topping with minimum 5m wide.</p> <p>Suitable open RCC drains shall be provided to dispose off storm water drain. Separate open RCC drains shall be provided to dispose off floor wash and plant effluents into RCC sump pits. Separate RCC sump pits shall be provided for different types of effluents. The paving shall be provided with slope of 1:500 to dispose the surface water/wash water to the nearest drain. All drains/pits shall be provided with Heavy duty electro forged GI grating cover.</p> <p>Sewer lines (Cast Iron), interconnected by sewer manholes (RCC) at regular intervals (not exceeding 30 meter centre to centre) shall be provided to dispose off sewage from main plant block.</p>			
5.13.01	<p>GROUND FLOOR SLAB OF BUILDINGS</p> <p>In all buildings including main plant building, the ground floor slab shall consist of minimum 150mm thick RCC M40 grade base slab over an under bed as specified below. The under bed for ground floor slab shall consist of 75mm thick M25 PCC on stone soling of 200mm compacted thick with 63 mm and down aggregate with interstices filled with well graded selected sand/ moorum/ non-expansive soil on compacted and dressed sub - grade. Reinforcement for the slab shall consist of minimum 8mm diameter bars @ 200 mm c/c at top & bottom of the slab in both directions. However, at passages, unloading & maintenance bays, stone soiling of minimum 400mm thick and minimum 10mm diameter bars @ 200 mm c/c at top and bottom in both directions shall be provided.</p> <p>Further, top surface of ground floor slabs shall be finished with 50mm thick metallic hardener topping.</p>			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.13.02	CIVIL WORKS FOR FIRE DETECTION & PROTECTION SYSTEM IN GROUND FLOOR/PAVING <p>Fire water pipes shall be provided with either RCC trench/buried underground/on pedestal.</p> <p>Fire water trenches shall be open RCC type trench with removable RCC cover. RCC valve pit alongside trenches and RCC fire trenches crossing drains shall also be provided as per requirement.</p> <p>Interlocking concrete block paving shall be provided over the buried fire water pipes as specified elsewhere in the specification.</p> <p>At road/ drain crossings, NP3 class hume pipe encased in RCC shall be provided as per requirement at a depth of minimum 1m from FGL for routing of fire water pipes.</p> <p>In case of rail crossings, NP4 class hume pipe encased in RCC shall be used instead of NP3 class hume pipe.</p> <p>Each of the outdoor deluge valve and accessories shall be provided with housing comprising of Brick wall and RCC roof.</p>			
5.14.00	DELETED			
5.15.00	WATCH TOWERS <p>Watch Towers shall be RCC construction with all-weather enclosure at 6m height. Watch Towers shall be provided at 600 m interval along the boundary as well as at corner turning points of the plant boundary. Watch Towers shall be provided with MS staircase.</p>			
5.16.00	DELETED			
5.17.00	DELETED			
5.18.00	DELETED			
5.19.00	DELETED			
5.20.00	Switchyard Civil Works			
5.20.01	Civil works for switchyard includes: <ul style="list-style-type: none">a. Towers, girders, lightning & lighting masts and equipment supporting structures including proto type assembly etc.,b. Foundations and supporting pedestals for towers, lightning & lighting masts, equipment supporting structures etc.,c. GIS building, Control room/ building, foundation for AC Kiosks as required etc.d. Foundations for Transformers and Reactors including oil pit, stone filling, laying and fixing of rails for movement of Transformers/Reactors , rail track, jacking pad and fire walls as required, arrangement for cabling etc. all completee. Earthing mat, single lane roads and R.C.C. drains in switchyard area including road/drain/trench crossings etc.,f. All necessary embedments, inserts, supporting structures & supporting members as required etc.g. Cable trenches in switchyard and inside GIS Building & Control room building			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	including civil works for panel fixing etc.			
5.20.02	Design Criteria			
5.20.02.01	<p>Gantry structure, which consists of open web towers connected by girders, shall be made of structural steel conforming to IS 2062 and duly galvanized conforming to IS: 2629 and IS 4759. All joints shall be bolted connections. All bolts for connections shall be of 16mm dia conforming to IS 12427 and of property class 5.6 as per IS 1367 (Part 3). Nuts shall conform to IS 1363 (Part 3) of property class 5. Foundation bolts shall conform to IS 5624 and property class shall be 4.6 as per IS 1367 (Part-3). Butt splice shall be used for splicing the main members and splice shall be located away from the node point. IS 802 “Code of practice for use of structural steel in overhead transmission line towers” shall be followed for design of structures. Height & type of towers shall be established based on electrical requirements. A provision of ± 30 degree angle of deviation of line in horizontal plane and ± 20 degree deviation in vertical plane is considered and the resulting worst combination of forces shall be considered for design. For all outgoing and incoming feeders, the conductor span shall be taken as 200m for design purpose.</p> <p>The analysis of towers and gantries shall be carried out with combined model of critical configurations of towers and gantries using any established structural analysis software like STAAD Pro. etc.</p>			
5.20.02.02	<p>Switchyard structures shall be designed for the worst combination following loads:</p> <div><div>1) Dead loads (load of wires/conductors, insulator, electrical equipment and structural members),</div><div>2) Live loads,</div><div>3) Wind loads</div><div><div>a. Switchyard gantries, towers, equipment supporting structures and lightning mast shall be designed as per IS 802. The wind load calculations shall be made as per IS: 802 except the parameters basic wind speed (Vb) and terrain category as stipulated in “Criteria for wind resistant design of structures and equipment”.</div><div>b. All other structures shall be designed as per IS 456 / IS 800. The wind load calculations to be made as per IS: 875 shall be with the parameters as stipulated in “Criteria for wind resistant design of structures and equipment”.</div></div><div><div>4) Seismic loads,</div><div>5) Loads due to deviation of conductor (gantries shall be checked for ± 30 deg. deviation in horizontal plane and ± 20 degree deviation in vertical plane),</div><div>6) Loads due to unbalanced tension in conductor/wire,</div><div>7) Torsional load due to unbalanced vertical and horizontal forces,</div><div>8) Erection loads,</div><div>9) Short circuit forces including snap in case of bundled conductors, etc.</div></div><p>Note:</p></div>			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<div><div><div>i. The occurrence of earthquake and maximum wind pressure is unlikely to take place at the same time. The structure shall be designed for either of the two. However, temperature stresses can be ignored, as these towers are freestanding structure in open space.</div><div>ii. Short Circuit forces and Wind pressure shall be considered to act together for design of switchyard structures</div><div>iii. Direction of wind shall be assumed such as to produce maximum stresses in any member for the combination of wind load with conductor tensions. The wind acting perpendicular and parallel to bus conductor and shield wire shall be considered separately.</div><div>iv. The conductor tension shall be assumed as acting on only one side of the gantry for the analysis and design of switchyard gantries.</div><div>v. The distance between terminal and dead end gantry shall be taken as 200 meters.</div></div></div>			
5.20.02.03	<div><div>Factor of safety:</div><div>The factor of safety for the design of members for Switchyard structures shall be considered as 1.5 for normal condition and broken wire condition and 1.2 for short circuit condition and broken wire condition.</div><div>Foundation shall be designed for factor of safety of 1.5 for normal and broken wire condition as well as for short circuit and broken wire condition.</div><div>Factor of Safety for stability of Tower and equipment foundation will be as per IS 1904 for normal and short circuit condition.</div></div>			
5.20.02.04	<div><div>Design consideration for switchyard equipment support:</div><div>The supporting structure for B.P.I., LA, CVT & Isolator equipment's shall be comprised of GI (ERW) pipe of grade YST:210 or of higher grade conforming to IS: 1161 & shall be designed as per IS 806 "Code of Practice for use of steel tubes in general building construction".</div><div>Minimum diameter of the pipe type support for 765kV structure shall be 300NB, 400kV structure shall be 250NB, for 220kV & 132kV structures shall be 200NB and that for 66kV & 33kV shall be 150 NB.</div><div>The supporting structure for CT, CSE & Wave Trap equipment shall be comprised of lattice structural steel conforming to IS 2062 and shall be designed as per IS: 802.</div><div>Common raft foundation shall be provided for each pole of isolator.</div></div>			
5.20.02.05	<div><div>Special design consideration for lightning Mast:</div><div>Diagonal wind condition shall be considered for lightning masts. Diagonal wind shall be taken as 1.2 times the wind calculated on Longitudinal/Transverse side. Lightning mast shall be provided with minimum two nos. of platforms as per requirement and an\ ladder for climbing purpose shall be provided up to platform at top level. Top of platform shall have grating, railing and toe guard plates. The minimum width of platform shall be 900mm. Live load of 300kg/m2 above platforms shall be considered for design of Lightning Mast.</div></div>			
5.20.02.06	<div><div>Design Criteria for structures not covered under Cl. 5.20.02.01 to Cl. 5.20.02.05</div></div>			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>The Switchyard Control Room building shall have RCC framed super structure with one brick thick wall cladding on exterior face. The Control room building shall consist of rooms/facilities/ equipment/ monorail as per system requirement. An open space of one meter width (minimum) shall be provided on the periphery of the panel rows and equipment to allow easy operator movement and access for maintenance purposes.</p> <p>The design of RCC structures shall generally be carried out using limit state method of design as per IS 456..</p> <p>The GIS building shall be a Steel framed superstructure with permanently color coated metal sheeting on roof and on all sides with 300mm overlap with brick. However, brick cladding shall be provided up to a height of 900mm from Finished Floor Level (FFL). GIS building shall consist of rooms/facilities/equipment/EOT crane as per system requirement. Design of steel superstructure shall be carried out by IS:800 and other relevant IS standards.</p>			
5.20.03	The architectural features including roof water proofing, rainwater down comers and RCC parapet walls etc. shall be as specified elsewhere in the specifications.			
5.20.04	The fabrication and erection of the switchyard works shall be carried out generally in accordance with IS 802 and IS 800. All materials shall be completely shop fabricated and galvanised.			
5.20.05	<p>All structural steel members including stub members, bolts, nuts, spring washers, etc., shall be hot dip galvanised after fabrication. Minimum section thickness should not be less than 4 mm.</p> <p>For Structural Member with thickness of 6.0 mm and above, weight of zinc coating shall be at least 0.900 kg/m² and member with thickness below 6mm, the minimum zinc coating shall be 0.610 kg/m² .</p> <p>For foundation bolts, zinc coating shall be at least 0.900 kg/m².</p>			
5.20.06	<p>Cable Trenches</p> <p>Cable trenches shall be provided for routing of cables as required and shall be of adequate size. The trenches located within switchyard shall project at least 300 mm above the finished formation level so that no storm water shall enter into the trench. The bottom of trench shall be provided with a longitudinal slope of 1:500. The downstream end of cable trenches shall be connected to sump pits. The precast covers shall not be more than 300mm in width and shall not be more than 65 kg. Lifting hooks shall be provided in the precast covers. Trenches shall be given a slope of 1:250 in the direction perpendicular to the run of the trenches. Angle of size 50x50x6 mm (minimum) with lugs shall be provided in the edges of RCC cable trenches and any other place where breakage of corners of concrete is expected. All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays. All internal cable trenches shall have minimum 6mm thick (o/p) chequered plate covers while external cable trenches shall have pre - cast RCC covers. However, the portion of the cable trench behind and sides of control panel / MCC shall be provided with suitable chequered plate covers as directed by the Engineer. Cable trenches inside switchyard, having depth more than 500mm, shall have wall thickness of minimum 150mm with two layer reinforcement.</p>			
5.20.07	<p>PCC Layer & Gravel Filling:</p> <p>PCC Layer and Gravel filling shall be provided as specified elsewhere in the specifications.</p>			
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CLAUSE NO.	<div style="text-align: center;"> TECHNICAL REQUIREMENTS  </div>		
5.20.08	<p>Before laying of PCC layer, the subgrade shall be properly compacted and the top layer of the soil shall be treated for anti-weed considering the type of weeds found in the vicinity. The anti-weed - soil sterilization details such as manufacturer's name, their specification, test certificate, etc. shall be furnished for Owner's approval. Any modification if required in the proposed anti-weed treatment chemical shall have to be done by the contractor at no extra cost to the Owner. The contractor shall be required to furnish a performance guarantee of three years for the anti-weed treatment. This guarantee shall be commenced from the date of completion of work or date of handing over, whichever is later. Stone/gravel shall be chemically inert, hard, strong durable against weathering, of limited porosity and free from deleterious materials. It shall be properly graded and shall meet the requirements of IS: 383.</p> <p>Transformer/reactor foundations</p> <p>Foundations of transformers/reactors shall be designed for seismic and wind loads in addition to other applicable loads. Solid RCC block foundation shall be provided for the main transformer/reactor block. Alternatively, transformer shall be supported on a RCC foundation comprising of common raft for rail supporting walls up to rail-cum-road along with pedestals for jacking pad, roller lock etc. Tie beams connecting roller lock pedestals at rail level shall also be provided. Common raft/solid RCC block shall be supported on soil or pile based on requirement specified elsewhere in the specification. Oil soak pit / oil water separation pit for transformer/reactor shall be provided as envisaged elsewhere in the specification. The oil soak pit shall be provided for each transformer and shall be filled with gravel of size 40mm. The volume of the soak pit shall be sufficient to store one-third (1/3) of the oil volume of transformer/reactor considering only 40% of the volume as available voids between gravel filling. The oil soak pit shall also be provided with a sump at the corner to allow drainage of water/oil from the soak pit. The Oil-water Separation pit shall be designed for an effective capacity of complete oil of one transformer having highest volume of oil along with 10 minutes of firewater. For calculating effective capacity of oil-water separation pit, effective depth excluding 200 mm freeboard below invert level of inlet pipe shall be considered. Plan area and depth of oil-water separation pit shall be decided based on above consideration. Oil-water Separation pit shall be provided with five separate chambers interconnected by pipes. First chamber shall be for collecting oil-water mix from transformers' soak pits in case of fire. After entering into first chamber, oil being the lighter in density floats above the water. The water from lower elevation flows in to subsequent chambers interconnected through galvanized MS pipes. The accumulated oil in the first chamber to be pumped out for subsequent usage or disposal. Water collected in the last chamber to be pumped out for subsequent disposal after treatment. Invert level of inlet Hume pipes (of NP-3 grade and adequate capacity), carrying oil and water from transformers soak pits, shall be designed for gravity flow. Freeboard of 200 mm shall be provided below the invert level of inlet pipes. Invert levels of interconnecting pipes of subsequent chambers shall be decided accordingly.</p> <p>Arrangement for moving the transformer into place using rail cum road, jacking pads and pulling blocks including inserts, as required, shall be provided along with the transformer/reactor foundations.</p> <p>RCC Firewall shall also be provided between the transformers wherever required.</p> <p>300 mm thick PCC M2 encasement all around the Pylon supports inside soak pit for fire fighting system shall be provided up to top of Stone filling. Coarse aggregate filling inside the transformer oil soak pit shall be carried out only after construction/erection of Pylon supports</p>		
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5.20.09	and PCC encasement.			
5.21.00	The switchyard roads, drains, fencing and gate shall be as specified elsewhere in the specification.			
5.22.00	DELETED			
5.23.00	DELETED			
5.24.00	DELETED			
5.25.00	DELETED			
5.26.00	DELETED			
5.27.00	ADMINISTRATION BUILDING			
	Salient Features			
	<p>The Administration Building shall be a three–storied RCC frame superstructure. The building shall have an RCC Lift structure accommodating the Lift Car. The structural framing plan and elevations shall be based on the architectural concept to be developed by the bidder. The minimum thickness of Lift Superstructure RCC Wall shall be 230mm.</p>			
	Design Concept			
	<p>The building shall be designed as moment resisting RCC sway frame in both the orthogonal directions. For general design guidelines IS 456 shall be followed and for ductile detailing (against seismic load) IS: 13920 shall be followed.</p>			
	Architectural Features			
	<p>This building shall be five storeyed (G+2 stories above) and minimum area 1000 sq.m. with RCC Frame structure& Autoclave Aerated Concrete Block masonry. Floor-to-floor height shall be minimum 4.50m. It shall have features of local architecture. . Hermetically sealed double glazing with toughened Glass to be provided for external glazing. There shall be provisions for Exhibition Hall, Conference Room for 50 persons, Canteen for 30 persons, Bank, Bank ATM space, meeting room of 10 person capacity at each floor, AHU, MCC Room, First Aid Centre, Library, offices. Separate common toilet facilities shall be provided for ladies and gents in each floor with toilet cubicles. One toilet shall be provided for physically handicapped at each floor. The building shall have provision of attached toilet with the cabin for senior executives (minimum 10 no.). 2Nos Lifts and minimum 2Nos stairs shall be provided. Lift shaft shall be of R.C.C wall. Covered parking space for 25 nos. cars shall be provided. Covered parking shall be of RCC construction. Open parking space for 40 nos. cars & 75 nos. scooters shall be provided.</p>			
	<p>Minimum 23 sq.m./car (including circulation area) and 5 sq.m./Scooter (including circulation area) shall be considered for working out parking space. The Admin building shall be fully IT enabled. 300x40 mm GI Raceway with standard length 2500 mm single compartment trunking raceways made from 14 gauge (minimum) pre-galvanised sheet including fasteners, floor support, connectors, bends cross-way,</p>			
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5.28.00	<p>earthing stud for fixing etc. complete as per requirement, drawings and instructions of EIC shall be laid under floors of service building for IT enablement. 350x350x50 mm Junction boxes of pre-galvanised sheet with cover plate for raceways shall also be provided. Minimum 70mm Floor finish margin shall be kept for installing metallic raceways. The rain water down comers shall be provided as per General architectural specification. The rain water down comers shall be suitably concealed by the external wall enclosure. Structural Glazing shall have hermetically sealed double glazing. Windows on south side shall have Building Integrated Photovoltaic Cell as Glazing. The glazing area shall be increased accordingly for proper lighting. External finish shall be combination of GRC Tile & aluminium composite panel.</p> <p>The Administration building shall be designed keeping in mind the Green building features, such as Bio climatic Architecture including shading, daylighting, efficient envelop design, orientation with respect to sun path and wind pattern etc., to ensure that building is climatically responsive and consumes less energy.</p> <p>The outer shell of the building shall have double wall having 250 mm thick inner wall and 125 mm thick outer wall with a gap of 450mm. There shall be covered Atrium of area minimum 150 Sqm. The atrium cover shall be in Dome shape and shall be finished with Multiwall Poly carbonate sheet of minimum 10 mm thickness having U-Value – 3.2W/m²K, Light Transmission < 65%, U.V. resistant, Fire rated. The multiwall sheet shall be supported with fixed to powder coated aluminium extruded framing including fabrication and erection of steel structural framing to obtain the required shape, with adequate provision for expansion including all fittings, anchoring accessories, fixtures, joint sealing with EPDM gaskets to make the complete structure water proof, fitting & fixing the complete Roof Light Structure to RCC/Steel structural member etc. complete.</p> <p>The building shall have terracing at different levels.</p> <p>O&M STORE BUILDING / PERMANENT STORE</p> <p>Salient Features:</p> <p>The scope of work of the Bidder shall be design & construction of all Civil, Structural and Architectural, water supply, plumbing & sanitary works of the O&M store building including supply of all materials. Loads due to Solar PV panels also to be considered on roof slab of the building The Permanent store Building shall comprise the following:</p> <p>a) Heavy Material Storage Hall</p> <p>The Heavy Material storage Hall shall have a Single Bay framed superstructure with RCC/Structural steel columns and structural steel roof truss and purlins supporting pitched roof. The roofing of the Heavy Material store shall be permanently colour coated insulated sandwiched metal sheet. An EOT crane shall be provided with chequered plate walkways at both ends inside the bay of the Heavy Storage Hall. The capacity of the EOT crane shall be 30MT. The clear height up to the bottom of roof truss of the Heavy material storage hall shall be finalized based on equipment/spare to be handled. At the crane rail level, chequered plate walkway with handrails shall be provided for the entire longitudinal span of the building on both sides. Walkway width clearance from the face of the column to the edge of the crane shall be minimum 600 mm.</p>		
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	<p>b) Light Material Storage Hall</p> <p>The Light Material Storage Hall with 3 tier Rack system shall have a Single Bay framed superstructure with RCC/Structural steel columns and structural steel roof truss and purlins supporting pitched roof. The roofing of light material store shall be permanently colour coated insulated sandwiched metal sheet. The light material store shall be fully covered with external brick wall of minimum 230mm thickness with provision for doors, windows, rolling shutters as per architectural concept.</p> <p>c) General Light Material Storage Hall</p> <p>The General Light Material Store shall be RCC structure with cast in situ RCC beams & slabs. The RCC building shall be two storied and all beam column joints shall be designed and detailed for adequate ductility.</p> <p>d) Office Complex</p> <p>Office complex of this store shall be a single storeyed RCC building.</p> <p>Architectural Features</p> <p>Total Floor area of the Permanent store building shall be 450 sqm.</p> <p>The minimum clear floor area of Heavy material storage hall shall be approximately 20% of the total area of the Permanent store with bay width of 15m and Clear floor height of 12.5 m. The minimum head room of heavy material store shall be evaluated by the bidder based on approved EOT Crane Clearance diagram and crane rail level.</p> <p>Heavy material store shall have column free space for easy movement of materials. The Heavy Material storage hall shall be fully covered with external brick wall of 250mm thickness with provisions for doors, windows, rolling shutters as per architectural concept. The minimum clear floor area of Light Material Storage Hall (with 3 tier storage) shall be approximately 20% of the total floor area of the Permanent Store. The height of the Light Material Storage Hall (with 3 tier rack system) from ground floor slab to bottom of roof truss shall be 10.0m. Other Part of building shall have Light Material storage of two storied with floor area of 600 sq.m. at each floor and clear height of 3.5 m. A part of this light material store shall have facility for storing electronic equipment / instruments. This particular area shall be airconditioned for dust proof environment.</p> <p>The General Light Material Store shall be two storied building, completely covered with 250mm thick brickwork, doors, windows & rolling shutters. The plan of the building shall be rectangular in shape with minimum floor area of approximately 20% of the total floor area of the Permanent Store.</p> <p>The area of the office complex building shall be approximately 17% of the total floor area of the Permanent Store, with clear height of 4.0m. The external Wall shall be 250mm thick brick wall with provisions for doors and windows. The central office shall</p>		
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5.29.00	<p>be provided for management and monitoring the stored materials. Adequate space shall be kept for loading unloading of materials. Office shall space for Supervisor/In-Charge room, general office cum record-documentation area, toilets, pantry, etc. shall be provided as per requirement. All the above mentioned four buildings shall be interconnected by means of a covered passage 5.0m wide. All the terraces of O&M Building shall be accessible by R.C.C staircases for the purpose of installation of Solar PV.</p> <p>External finish shall be of Premium Acrylic Smooth Paint with Silicone additives.</p> <p>FIRE STATION BUILDING AND DRILL TOWER</p> <p>Salient Features</p> <p>The Fire Station Building shall be a RCC framed superstructure. The building shall be designed as per the latest guidelines of IS:456, IS 1893 & IS 13920(for seismic ductility requirement)</p> <p>It shall be of RCC Frame structure& Brick masonry</p> <p>Drill tower to be six storeyed building building with stair access to each floor. The stair width to be minimum 1200mm. Drill tower to have drill area and hose drying area Drill tower to conform to IS:5888</p> <p>Under Ground Tank and Cover in RCC of adequate capacity to be provide to facilitate water filling</p> <p>Architectural Features</p> <p>The building shall be provided with area 240 sq. m required to accommodate Fire tenders and fire personnel including Dy./Asst. Commandant's (Fire) office. The number of fire tenders shall be provided as per CISF norms. The number of fire tenders/ equipment shall be provided as given in elsewhere in specifications. One drill tower per station shall be provided. Facilities for the staff including Kitchen, Dining Hall, Rest Rooms, Stores, First Aid Room shall be provided as applicable.</p> <p>External finish for fire station and drill tower shall be Premium Acrylic Smooth Paint with Silicone additives.</p>			
	5.30.00	<p>CANTEEN</p> <p>Salient Features</p> <p>The Canteen Building shall be a RCC framed superstructure with large span roof system. The building shall be designed as per the latest guidelines of IS:456, IS 1893 & IS 13920(for seismic ductility requirement). The roof shall be designed for installation of solar PV panels.</p> <p>Architectural Features</p>		
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5.31.00	<p>This building shall be of RCC Frame structure& Autoclave Aerated Concrete Block masonry.The area of building shall be 840 sq.m. excluding the area of porch and staircase. The building shall have entrance lobby, dining hall for staff, dining room for executives, pantry, kitchen, office, stores, wash areas, rest room for kitchen staff, toilets, etc. The roof shall be accessible by R.C.C staircase The Canteen building shall be designed keeping in mind the Green building features, such as Bio climatic Architecture including shading, daylighting, efficient envelop design, orientation with respect to sun path and wind pattern etc., to ensure that building is climatically responsive and consumes less energy. There shall be separate service road and entrance for supply of cooking materials and garbage disposal.</p>				
	<p>PARKING</p> <p>20 nos. of covered car parking and 54 nos. of covered scooter parking shall be provided in addition</p> <p>to all other parking requirements as specified with buildings.</p> <p>Salient Features of Parking Structure</p> <p>Parking Structure both four wheeler and two wheeler shall be in RCC-Steel framed structure with metal sheet roofing</p> <p>In addition to general loads, they should considered with Solar Loads</p> <p>Paving in Car Parking (Covered and Open) and Two Wheeler Parking shall be normal duty paving. Paving areas shall be provided with the metallic hardener floor finish as specified else wherein the specification</p>				
	5.32.00	<p>SHEDS FOR CONSTRUCTION WORKERS AND O&M WORKERS</p> <p>Salient Features</p> <p>Sheds for Construction workers and O&M Workers shall be permanent steel structure with roof provided with insulated sheeting. . The sheds to be scattered as per work locations and suitably located. Bidder to refer Tender Drawing titled ‘Sheds for Construction workers and O&M Workers’. Minimum two no of workers shed to be provided</p> <p>Architectural Features</p> <p>The shed should accommodate common rest room, cooking area, Food serving kiosk, drinking. water facility, toilet and bathing area along with covered verandah for easy approach to facilities. The sheds should be well ventilated. Bidder to refer Tender Drawing titled ‘Sheds for Construction workers and O&M Workers</p> <p>External finishes shall be Premium smooth Exterior Paint with silicone additives over Texture Coat</p>			
		5.33.00	<p>O&M Workshop Building(to be modified for requisite area and requirement)</p> <p>The O&M Workshop Building shall be a two bay fully covered building. The two bays shall comprise of workshop bay and office complex bay. The minimum span of workshop bay shall be 25m with RCC columns, structural steel roof truss and 40mm thick RCC roof slab supported</p>		
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	<p>on troughed permanently colour coated metal decking sheet and purlins. Roof water proofing shall be applied on roof slab as per details specified elsewhere in this specification.</p> <p>The Gantry girder for the EOT crane in the workshop building shall be structural steel plate girder supported on RCC corbels at column locations. The gantry girder shall be complete with chequered plate walkways (at both sides) and the cage ladder.</p> <p>The adjacent Office Complex bay shall have RCC superstructure. The minimum bay width shall be 6.50m.</p> <p>Architectural Features:</p> <p>The building shall be fully covered with brick wall masonry. provision of doors, windows & Rolling shutters shall be included based on architectural detailed drawing to be developed by the bidder. The rainwater down comers shall be provided at every column location and they shall be suitably connected to the building surface drain.</p> <p>The minimum operating floor area for the workshop bay shall be 25mX110m. The overall area of the building shall be 4100 sq.m</p> <p>The minimum head room of workshop bay shall be evaluated by the bidder based on approved EOT Crane Clearance diagram and crane rail level.</p> <p>The office complex shall preferably be 6.50mX110m in plan area. The office complex shall preferably be made 2 storied for adequate space for operating personnel, MCC room, stores, Laboratories, Toilets, Conference room & Tool room. The floor to floor/ roof clear height shall be 4.50m.</p>			
5.34.00	SAFETY PARK Safety Park to be provided for the project			
5.35.00	SAFETY CONTROL ROOM Safety control room shall be a single storied RCC framed building of minimum area 36 sqm to accommodate equipments and personals as mentioned in C&I chapter for 24X7 operation. Additionally, it shall have ladies and gents toilet, space for water cooler and Pantry.			
5.36.00	Worker's Accomodation Buildings Accommodation for Workers & staff colony in adequate numbers as required for the project peak demand shall be made in the form of temporary structures which shall be removed after completion of the project. It shall have facilities for drinking water & sanitation, approach road, dust suppression, drainage, sewage treatment plant, solid waste collection & disposal, fuel for cooking, medical healthcare, creches, Occupational Health Center etc. The Occupational health centre with creche facility shall be a single storied Temporary structure building of minimum area of 300 sqm. meeting the statutory requirements.			
5.37.00	DELETED			
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<div>5.38.00</div> <div>5.39.00</div> <div>5.40.00</div> <div>5.41.00</div> <div>5.42.00</div>	<div> DELETED </div> <div> HARD CRUSTING </div> <div> <p>Hard crusting in preassembly area and any other areas shall be done with 63mm to 45mm graded stone aggregate, watering and compacting each layer (not exceeding 200mm in thickness) to minimum of 85% of original volume of stone stack including filling the interstices of stone aggregate with moorum/ locally available non-expansive soil. The minimum compacted thickness of stone aggregate layer shall be 200mm. The compacted subgrade below stone aggregate shall be 85% of standard proctor density.</p> </div> <div> OTHER BUILDINGS </div> <div> <p>For all other buildings mentioned in the scope of work but requirement not furnished in this chapter, the Bidder shall develop the details of such buildings based on the functional and statutory requirements.</p> </div> <div> <p>OWNERS CONSTRUCTION OFFICE – Building with total area of 1440 Sq.M. with Pre-fabricated structure to be constructed</p> </div> <div> <p>CONSTRUCTION STORES – RCC buildings with size of 2X1050 Sq.M. to be constructed for construction material storage</p> </div>		
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D-1-6				
6.00.00	DESIGN CRITERIA AND GENERAL SPECIFICATION			
6.01.01	General			
	The design criteria given herein is applicable for all sub-structure, super-structure works/ buildings/ facilities and various other works included in the scope of the Bidder.			
6.01.02	Structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, piping loads (static, friction and dynamic), earth pressure & surcharge loads, hydrostatic & hydrodynamic loads, wind loads, seismic loads and temperature loads. In addition, Erection loads, loads and forces developed due to differential settlement shall also be considered.			
6.01.03	<div>i) All the buildings shall have framed super structure. If the superstructure of building is a steel structure, the framed superstructure shall be moment resisting sway frame in the lateral direction and axially braced in the orthogonal direction. For columns having depth of 1000mm & above, the longitudinal bracings shall comprise a pair of members (spaced) with spacing equal to the column depth. Columns having depth less than 1000mm may have bracing in single plane and at the centerline of column. In both the cases (single bracing or pair of bracing) detailing shall be adequate to restrain the entire column cross-section including both the flanges. Only where axial bracing to one vertical plane is to be waived due to functional requirement, columns in that vertical plane may be allowed to undergo biaxial bending. Beam column joints shall be detailed as per seismic resistant joint with adequate ductility.</div> <div>All 2-legged structural steel trestles shall be completely braced in the vertical plane. All 4-legged structural steel trestles shall be completely braced in all four vertical planes. In addition, specified horizontal planes shall be completely braced to provide stiffness against torsional sway.</div> <div>If the superstructure is RCC structure, the superstructure shall be moment resisting sway frame in both orthogonal direction and all the members shall be designed for biaxial bending. Design of RCC structures shall be done as per IS 456. Detailing for ductility shall be followed as per guidelines of IS13920 to be effective against seismic load. Design of liquid retaining structures shall be done as per IS 3370.</div> <div>ii) Inlet and exhaust duct support structures, Compressor House, Pipe cable Gallery shall have structural steel framed super structure.</div> <div>iii) All other buildings may have either RCC or structural steel framework.</div> <div>iv) All buildings having RCC framing shall have masonry cladding of minimum one masonry unit thickness (not less than 230 mm.) on exterior face.</div>			
6.02.00	Loading			
	For consideration of loads on structures IS : 875 - 'Code of practice for structural safety of buildings' shall be followed. In addition to the dead load, live load, equipment load (including impact / vibration), Temperature loads etc. various loading conditions arising due to operation and maintenance of equipment shall be considered in the design.			
6.02.01	Dead loads			
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6.02.02	<p>Dead loads shall include the weight of structure complete with finishes, fixtures and partitions and shall be taken as per IS: 875 (Part-I).</p> <p>For Structural steel analysis & design, Self weight factor of minimum 1.15 shall be applied in structural model to account for elements such as stiffener plates, gussets, lip sections, etc.</p> <p>Imposed loads</p> <p>Imposed loads in different areas shall include live loads, erection, operation and maintenance loads. Equipment loads (which constitute all loads of equipment to be supported on the building frame) are not included in the imposed loads furnished below and shall be considered in addition to imposed loads.</p> <p>For consideration of imposed loads on structures, IS:875 (Part-2) “Code of practice for design loads (other than earthquake) for buildings and structures” shall be followed. The following minimum imposed loads as indicated for some of the important areas shall however be considered for the design. If actual expected load is more than the specified minimum load, then actual load is to be considered.</p>		
	Sl.No	Location	Imposed Loads (T/Sq.m.)
	A)		
	F)	Pump Houses Operating floor	1.50
	G)	Underground Structures such as Channels, Sumps, Underground Pump House, Tanks, Trenches, Reservoirs, C.W. ducts etc.	In addition to earth pressure and ground water pressure, the surcharge load of 2T/sq.m. shall also be considered for design of all underground structures.
	H)	Road Culverts/Bridges and its allied structures including RCC Pipe Crossings and Road Crossing of Trenches.	Design for class ‘AA’ loading (wheeled and tracked both) and checked for class ‘A’ loading as per IRC Standard.
	I)	Covers for Channels/trenches	0.40 (General) or central point load of 75 kg whichever is higher As per IRC Standard (at road crossings for vehicular traffic)
	L)	Floor of control room of Switchyard Control building	1.0
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	Sl.No		Location	Imposed Loads (T/Sq.m.)
		i)	Stairs, Landings and Balconies, Chequered plates, grating floors, etc. RCC floors (General)	0.50
		ii)	Toilets	0.20
		iii)	Roof (including inclined Roofs)	0.15 (Where no equipment are located) 0.50 (Where equipment are located) 0.075 (For Inaccessible roof)
		iv)	Dust load on roof	0.05
		v)	Walkways	0.50 (General) 0.30 (Conveyor galleries, DM & PT) 0.40 (Pipe & Cable trestles, in addition to frictional loads as applicable)
		vi)	Grating covers/ Precast RCC covers for drain, trench, sump pit in Ground floor/ paving	2.50 As per IRC standard (at road crossings for vehicular traffic)
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	Table 0-1. The specific minimum floor live loads are listed			
	Roofs			
		-	1.5 kN/sqm plus hung loads for accessible roofs	
	Flat Roof	-	0.75 kN/sqm plus hung loads for non-accessible roofs.	
		-	5.0 kN/sqm for accessible roofs with HVAC equipment etc	
	Sloped Roof	-	As per IS:875	
	Dust Loads on Roof, floors and platforms open to atmosphere.	-	1.0 kN/sqm	
	Control Building and other electrical buildings			
	a.	Control Room Floor & switchgear room	-	10 kN/sqm
	b.	Cable Vault Floor	-	5 kN/sqm in addition to actual cable loads
c.	Cable tray loads	-	1.0 kN/m or as specified in Electrical Drawings	
d.	Minimum live load	-	5 kN/sqm	
e.	Roof	-	1.5 kN/sqm	
Other Areas				
	RCC Floors	-	5 kN/sqm for offices	
	Stairs and balconies	-	5 kN/sqm	
	Chequered Plate / gratings	-	The gratings/chequered plates shall be designed for minimum live load of 5 kN/sq.m	
	Walkways	-	3 kN/sqm	
	Toilet rooms	-	2 kN/sqm	
	Notes:			
	a) If erection load is higher than the specified imposed loads on any floor or part thereof, then the erection loads are to be considered for the design.			
	b) Additional load for cable, piping/ducting, shall be considered as applicable. For any other structures, the loads specified for those structures elsewhere in the specification shall be followed.			
6.02.03	Equipment, piping, cable and associated loads			
	Equipment, piping, cable and associated loads shall be considered over and above the imposed loads. Equipment loads shall be considered as given by equipment supplier. These loads shall be treated as dead loads in the analysis and design.			
6.02.04	Crane load			
	For crane loads, an impact factor of 25% and lateral crane surge of 10% (of lifted weight + trolley weight) shall be considered. The longitudinal crane surge shall be 5% of the static wheel			
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	load. These loads with impact factors shall be used in the analysis and design of crane girders, surge girders, columns, baseplates & foundation bolts. Longitudinal surge and lateral surge shall not be considered to act simultaneously.			
6.02.05	Seismic load	For design of all structures, the site specific seismic design criteria as attached in Annexure-E shall be followed.		
6.02.06	Wind load	For design of all structures, the wind loads shall be taken as per the site specific wind data specified in Annexure–D of this specification.		
6.02.07	Temperature Load	For temperature loading, the total temperature variation shall be considered as 2/3 of the average maximum annual variation in temperature. The average maximum annual variation in temperature for this purpose shall be taken as the difference between the mean of the daily minimum ambient temperature during the coldest month of the year and mean of daily maximum ambient temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation. This load shall be considered on all the structural elements.		
	Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns. The maximum distance of the expansion joint shall be as per the provisions of IS 800 and IS 456 for steel and concrete structures respectively. In Limit state design, the partial safety factor for temperature load in load combinations shall be taken same as specified for dead load (DL) in Table 4 of IS 800: 2007 for steel structures and in Table 18 of IS 456 for concrete structures.			
6.02.08	Deleted.			
6.02.09	Additional Loads	Following additional Loads shall be considered as per the requirement:		
	(a)	Loads as defined in Mechanical/ Electrical input drawings		
	(b)	Loads for solar installations over roof of all buildings to be taken not less than 1 KN/sqm in addition to live loads, dust loads etc as mentioned elsewhere. Roof slab to be design for local effect due to wind load at support location for installations. Solar panel load and its foundation load is to be considered as dead load for seismic load calculation.		
6.03.00	Civil Design Concepts			
6.03.01	Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.,			
6.03.02	The different load combinations shall be taken as per IS: 875 (Part-5) and other relevant IS Codes.			
	a)	Wind and seismic forces shall not be considered to act simultaneously.		
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	<p>b) For the design of main plant structures during seismic condition, the deaerator feed water tank shall be considered full upto operating level. However, for other load combinations, deaerator feed water tank in flooded condition shall be considered.</p> <p>c) 'Lifted load' of crane shall not be considered during seismic condition.</p> <p>d) In case two cranes are provided and tandem operation is not envisaged, the load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane all through the building length (lifted load near to A/B Row).</p> <p>e) In case two cranes are provided and tandem operation is envisaged then the crane wheel loads shall be taken as both the cranes fully loaded to capacity and travelling side by side al through the building length.</p> <p>f) Permissible limit states for different load combinations shall be taken as per relevant IS and IRS codes.</p> <p>g) Wherever pipe cable trestle is routed through filled up area, soil overburden weight to be accounted from natural ground level to finished grade level in foundation design as in other structures.</p> <p>h) Frictional forces between the pipes and supporting structure in longitudinal direction need not be considered along with seismic or wind forces.</p> <p>i) Paving in crane corridor shall be designed for the maximum load due to movement of crane.</p> <p>j) In Engine hall at crane rail level, chequered plate walkway with handrails shall be provided for entire column sectional depth for full length of the building. Walkway width clearance from the face of the column to the edge of the crane shall be as specified elsewhere in the specification.</p> <p>k) For checking against uplift / tension case, 90% of Dead Loads with no Imposed Loads shall be considered along with other Loads. However, Seismic loads used in such combinations shall be estimated using imposed loads also in addition to all other loads.</p> <p>l) The Structures shall be Designed for most unfavourable Combination of Dead Loads, Imposed Loads, Equipment Loads, Piping / Cables / Ducts Loads, Wind / Seismic Loads, Temperature Loads, Ash Loads, and other applicable Loads without exceeding the Permissible limit states.</p> <p>m) No reduction in equipment loads, piping loads, coal loads, limestone loads, gypsum loads, biomass loads, ash loads and loads due to other permanent facilities shall be considered for calculation of seismic weight of the building/structure and for load combinations thereof.</p> <p>n) In all Loading Combinations, the Loads that have reduction effect on design condition shall not be taken into account in the Combination concerned.</p> <p>o) In all Load Combinations, temperature loads (with reversible effects) are to be considered</p> <p>p) Deleted.</p> <p>q) Foundations shall be designed for all the load combinations for which Structure has been designed in addition to the load combinations mentioned in respective codal provisions.</p>			
6.03.03	Design of steel structures shall be done as per provisions of IS:800: 2007 (Limit state design) and other relevant IS standards including National Building Code (2016).			
6.03.04	Shop connections and connections in fabrication yard will be welded type. All field connections will be bolted. Field permanent bolts wherever provided will be high tensile bolts of property class 8.8(min) as per 1367 for all major connections. However, nominal connections in the field			
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6.03.05 6.03.06 6.03.07 6.03.08 6.03.09	like purlins, stairs, wall beams will be done by means of M.S. black bolts of grade 4.6 conforming to IS-1367. The bolted joints will be designed for friction grip or bearing type. For friction grip type connections, bolts will be tightened to develop the required pretension during their installation.																		
	For bolted Connection, IS 4000, IS: 3757, IS: 6623 and IS: 6649 shall be followed. IS 814, IS 816, IS: 1024, IS 4353 and IS: 9595 shall be followed for welding of structures.																		
	All structures close to railway line shall have clearances conforming to Railway norms.																		
	Deleted																		
	Deleted																		
	DELETED																		
	Horizontal Deflection criteria																		
	The maximum Horizontal Deflection for various structures shall not exceed and be limited to the following:																		
	<table><tr><th>Sl. No.</th><th>Description</th><th>Maximum value of</th></tr><tr><td>1.</td><td>For Trestles (Transverse deflection at Conveyor gallery supporting level)</td><td>Height/1000 (For Wind load by Peak Wind Speed Method / Seismic Load)</td></tr><tr><td>2.</td><td>For Trestles (Longitudinal deflection at Conveyor gallery supporting level)</td><td>Height/500 (For Wind load by Peak Wind Speed Method / Seismic Load)</td></tr><tr><td>3.</td><td>For all other steel buildings envisaged in this specification</td><td>Height /325</td></tr><tr><td>4.</td><td>Vertical Metal Sheeting in Cladding</td><td>Span/250</td></tr></table>				Sl. No.	Description	Maximum value of	1.	For Trestles (Transverse deflection at Conveyor gallery supporting level)	Height/1000 (For Wind load by Peak Wind Speed Method / Seismic Load)	2.	For Trestles (Longitudinal deflection at Conveyor gallery supporting level)	Height/500 (For Wind load by Peak Wind Speed Method / Seismic Load)	3.	For all other steel buildings envisaged in this specification	Height /325	4.	Vertical Metal Sheeting in Cladding	Span/250
	Sl. No.	Description	Maximum value of																
1.	For Trestles (Transverse deflection at Conveyor gallery supporting level)	Height/1000 (For Wind load by Peak Wind Speed Method / Seismic Load)																	
2.	For Trestles (Longitudinal deflection at Conveyor gallery supporting level)	Height/500 (For Wind load by Peak Wind Speed Method / Seismic Load)																	
3.	For all other steel buildings envisaged in this specification	Height /325																	
4.	Vertical Metal Sheeting in Cladding	Span/250																	
However, the maximum deflection of Grating / Chequered Plate Shall be limited to 6mm.																			
6.03.10	Note: Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.																		
	Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than “5” and/or if the fundamental frequency of the structure is less than 1 Hz.																		
	a)	Dispersion of load in any direction through soil shall be as per IS 8009 (relevant part).																	
	b)	Dispersion of load through concrete shall be considered at an angle of 45 degrees with																	
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CLAUSE NO.	<div style="text-align: center;"> TECHNICAL REQUIREMENTS  </div>		
6.03.11	<p>horizontal from the edge of contact area.</p> <p>a) Permissible deflection (unless specified otherwise in this specification) for latticed framework and beams of floors other than drive floor shall be span/325.</p> <p>b) The allowable deflection for beams directly supporting drive machinery and equipment shall be restricted to span/500 unless specified otherwise in this specification.</p> <p>c) The deflection for manually operated cranes & monorail supporting beams shall not exceed span/500.</p> <p>For electric overhead cranes :</p> <p>1) up to 50 Tonne capacity : span/750</p> <p>2) over 50 Tonne capacity : span/1000</p> <p>d) The vertical deflection of beams supporting LP Heater, HP Heater and Deaerator shall be limited to Span/500.</p> <p>e) The vertical deflection of metal deck sheet for floor shall be limited to span/250.</p> <p>f) Permissible deflection for all purlins, cladding runners, roofing/cladding sheets and grating / chequered plates shall be span/250. However, the maximum vertical deflection of Grating/ Chequered plate shall be limited to 6 mm.</p>		
6.03.12	<p>Transverse coal pressure on Bunker/Silo/Hopper walls shall be calculated as per IS: 9178. The Coal Bunker/Silo/Hopper shall be designed for the following conditions</p> <p>i) The Bunker/Silo/Hopper is full up to its full capacity with top surface nearly horizontal.</p> <p>ii) The Bunker/Silo/Hopper is partially empty with the top surface of coal at an angle of repose of 37 degrees.</p> <p>Stored Coal load (with density of 1100 kg/cum) shall be treated as dead load for analysis and design of bunker and supporting structure in all loads and load combinations including seismic loads.</p>		
6.03.13	DELETED		
6.03.17	<p>a) Design of Machine Foundations</p> <p>Structural Arrangement of foundations for various machine foundations shall be as specified elsewhere in the specification.</p> <p>b) Analysis for the foundation</p> <p>For the foundations of all equipment, details static and dynamic analysis shall be done. The static analysis shall include all operating condition, load cases and abnormal loads like short circuit, loss of blades & unbalance and seismic forces as per IS1893. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. A minimum fatigue factor of 2.0 shall be considered for dynamic forces.</p> <p>The vibration amplitudes shall be calculated at the machine bearing locations and at any other points of interest by a forced response analysis. The unbalance forces used for this analysis shall correspond to the balance quality grade of the machine as per ISO 1940 /IS:11723 or the unbalance forces as provided by the machine manufacturer whichever is higher. It shall be</p>		
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6.03.18	<p>ensured that the calculated amplitudes do not exceed the limits specified by the machine manufacturer and relevant Standards such as ISO 10816/IS:14817.</p> <p>Bidder to consider the acceleration at the top of the deck for the design of supporting / fixing arrangement of machine.</p> <p>c) Design criteria for steel helical springs and viscous dampers</p> <p>The isolation efficiency for steel helical springs and viscous dampers shall be at least 90%. The ratio of actual spring supported weight to the nominal spring capacity shall not exceed 0.80. At least 5% to 10% of critical damping shall be provided in the form of viscous dampers.</p> <p>d) Reinforcement Design</p> <p>Working stress method as per IS 456 shall be used for reinforcement design. The design shall be done for the worst load combination. Minimum reinforcement shall be provided as per IS 456 and IS2974 (Part-III), if the calculated reinforcement is less than the minimum.</p> <p>For framed foundations Raft/ Pile cap, minimum percentage of reinforcement at top and bottom faces of foundation shall be same as that stipulated for beam as per IS456.</p> <p>e) Block Foundations:</p> <p>Block foundation resting on soil shall be analyzed using elastic half space theory. In case the foundation is supported over piles, Novak's approximation shall be used for determining the spring constant and damping ratio of pile groups. The mass of the RCC block shall be at least three times the mass of machine. Free vibration analysis of the foundation shall be carried out to evaluate the natural frequencies. The fundamental natural frequency shall be kept at least 20% away from the operating frequency (speed). Forced vibration analysis shall be carried out if the dynamic forces are made available by the machine supplier in which case the amplitude limits stipulated by the machine supplier and ISO 10816, whichever is lower, shall be satisfied.</p> <p>Reinforcement design shall be done by working stress method as per IS 456 and IS 2974 (Part-IV).</p> <p>For the foundations supporting minor rotating equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structure, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc., and such vibration isolation system shall be designed suitably.</p> <p>If RCC floor/roof is assumed to act as diaphragm, transmitting lateral loads to braced bays, it shall be provided with shear connectors.</p> <p>The spacing of shear anchor studs on structural beams shall be minimum of the spacing required for</p> <p>i) Restraining the compression flanges of beams and</p> <p>ii) Transfer of the horizontal shear at floor/roof to the supporting beams.</p> <p>However, whenever large / more number of cut-outs are provided in the floor slab, horizontal floor bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab.</p>		
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6.03.19	All roads shall be rigid pavements specified elsewhere in this specification. The design traffic load shall be a minimum 4 million cumulative standard axle. The design of concrete pavement shall be carried out as per IRC-58.			
6.03.20	<div>a) No cable/pipe trench is envisaged in the plant area. However, if required, pipe/cable trench can be provided inside the buildings and inside switchyard or some other localised areas.</div> <div>b) All pipes and cable shall generally be routed above ground.</div> <div>c) A minimum clearance (clear headroom) of 8m shall be kept for all over-ground pipe/cable trestles for all road/rail crossings. For other areas, the requirement of trestle height is specified elsewhere in the specifications. All trestles shall be provided with continuous walkway of minimum 600mm width with hand-rails and toe-guards all along the length of the trestle along with approach ladders near roads, passageways, etc.</div> <div>d) Within AB bay in Main plant area, generally grating shall be provided for Mezzanine floor except for valve room area, cable spreader floor, air washer units, feed water heaters, equipment foundations, miscellaneous skids, etc. where the floor shall be of RCC. Oil equipment room shall also have RCC floor below the grating floor.</div>			
6.03.21	The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8 m/sec. respectively. However, minimum velocity of 0.6m/sec. for self-cleansing shall be ensured. Bed slope not milder than 1 in 1000 shall be provided. The open drains shall be open rectangular drains of RCC unless required otherwise due to functional requirement. RC box culverts shall be provided at rail, road or other crossings.			
6.03.22	<div>Sewers shall be designed for a minimum self-cleansing velocity of 0.75m/sec and the maximum velocity shall not exceed 2.4m/sec.</div> <div>Manual on sewerage and sewage treatment (published by Central Public Health Environment Engineering Organisation, Government of India) shall be followed for design purpose.</div>			
6.03.23	Foundations for all tanks shall be designed for as per IS: 803.			
6.03.24	Footings shall be so proportioned to as to minimise the differential settlement.			
6.03.25	Plinth level of all buildings shall be kept at least 500 mm above the finished grade/formation level.			
6.03.26	DELETED			
6.03.31	DELETED			
6.03.32	<div>Design Criteria of RCC Floors</div> <div>a) For Mill Bunker Building, Main Power House, ESP Control Building, Transfer Houses, and other structural steel framed buildings:</div> <div>These buildings being steel framed structure, all RCC floors shall comprise RCC slab supported on troughed, profiled metal deck sheet (to be used as permanent shuttering). The RCC slab shall be minimum 150mm thick above the top surface</div>			
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CLAUSE NO.	<div style="text-align: center;">TECHNICAL REQUIREMENTS</div> <div style="text-align: right;"></div>		
6.03.33	<p>(crest) of the metal deck sheet. The spacing of structural steel secondary beams shall be based on the bending capacity of the metal deck sheet for self-weight of green concrete and additional construction load of 100 kg/m².</p> <p>The permanent metal deck sheets shall be fixed to the top flange of secondary beams by means of drawn arc welding of headed shear anchor studs directly through the metal sheet. The details of shear anchor studs are specified elsewhere in this specification.</p> <p>The RCC slab shall be designed without considering any composite action effect of metal deck sheet (i.e. the structural strength of metal deck sheet shall not be considered for RCC slab design).</p> <p>(b) For RCC buildings.</p> <p>These buildings being complete RCC framed structures, conventional RCC slabs of minimum thickness 150 mm shall be provided. The RCC slabs shall be monolithic with RCC beams and RCC columns.</p> <p>Design Criteria of RCC roofs</p> <p>a) For Main Power House, Compressor House, ESP Control Building and Other Steel framed Buildings with minimal equipment loading:</p> <p>The roof system shall comprise minimum 40mm thick RCC slab on top of profiled permanent metal deck sheet. The permanent metal deck sheets shall be fixed to the top flange of secondary beams by means of arc welding of headed shear anchor studs to the purlins directly through the metal sheet. The details of shear anchor studs are specified elsewhere in this specification. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification).</p> <p>The RCC slab shall be designed without considering any composite action effect of metal deck sheet (i.e. the structural strength of metal deck sheet shall not be considered for RCC slab design).</p> <p>b) For Mill Bunker Building, Transfer Houses.</p> <p>Insulated sandwiched metal sheet for roofing shall be provided comprising troughed permanently colour coated sheet at top and plain permanently colour coated sheet at bottom with 50mm thick insulation sandwiched between the two sheets, the details of which are specified elsewhere in this specification.</p> <p>c) DELETED</p> <p>d) Other RCC Buildings.</p> <p>Cast-in-Situ RCC slab shall be provided using removable plywood shuttering. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification).</p>		
	<p>Design Criteria for Foundation</p> <p>The founding depth / cut off level of piles shall be decided based on functional requirement.</p>		
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6.04.00 6.04.01	<p>Wherever structural steel columns are envisaged, the bottom of the base plate shall be kept suitably below the paving level such that the top level of the gusset plate and foundation bolt remain at least 200 mm below the top level of paving. Further the gusset plate and foundation bolts are to be encased with RCC up to the top of the paving level by providing skin reinforcement of 8mm dia at 100mm c/c on all faces (Minimum 400mm anchorage of vertical skin reinforcement into the Pedestal shall be provided).</p> <p>Further, for all structural steel columns (both indoor and outdoor), about 350 mm height of steel columns above the top of paving level shall be provided with at least 125 mm thick RCC encasement with skin reinforcement of 8mm dia at 100mm c/c on all faces (Minimum 400mm anchorage of vertical skin reinforcement into the baseplate encasement shall be provided).</p> <p>a) OPEN Foundations</p> <p>For foundations, the minimum founding depth and the minimum size of foundation shall be as per foundation system and geotechnical data specified in the foundation chapter include hereafter in this specification.</p> <p>For open foundations, the total permissible settlement shall be as per the criteria furnished under the foundation system specified elsewhere in this specification.</p> <p>The sizing of foundation, design criteria & clear cover shall conform to IS:1904, IS:456 and other relevant Indian codes. However, minimum 0.12% of reinforcement shall be provided on the top face of the foundation concrete on either direction and minimum percentage of reinforcement both in case of bottom face and also for tension face of foundation shall be same as that stipulated for beam as per IS:456.</p> <p>b) PILE Foundations</p> <p>Minimum centre to centre spacing of the piles shall be as per IS: 2911. Incase single piles are used, these piles are to be interconnected with tie beams along both orthogonal directions perpendicular to each other.</p> <p>Minimum penetration of piles into Pile cap shall be 75 mm and clear cover to the main reinforcement at the bottom face of the pile cap shall be 100 mm. Structural design of pile cap and reinforcement shall conform to IS:2911 and IS:456. However minimum 0.12% of cross section of the pile cap shall be provided on the top face of the pile cap along two orthogonal directions and minimum percentage of reinforcement at bottom face and also for tension face of pile cap shall be same as that stipulated for beam as per IS:456.</p> <p>Detailed requirement of open and pile foundation has been presented in the foundation chapter in this specification.</p>			
	CORROSION PROTECTION			
	General			
	<p>(a) All Steel structures shall be provided with painting system as mentioned below in this specification for the Corrosivity category mentioned in Part A-IID-Civil Works.</p> <p>Painting system for steel surfaces embedded in Concrete is given separately.</p> <p>(b) All Painting shall be done as per Technical Specification Painting scheme shall</p>			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
6.04.02	submitted by the Bidder.			
	(c)	All steel structures shall be designed by following basic design considerations in ISO 12944 Part 3. Where steel is fully accessible for cleaning and repainting and where it is feasible to follow design criteria given in ISO 12944 part 3, minimum thicknesses of structural members shall be as follows:		
<p>Where steel surfaces are inaccessible for cleaning and repainting (such as back-to-back sections, lap joints etc.) or where it is not feasible to follow design criteria given in ISO 12944 part 3, corrosion allowance of 1.5 mm shall be kept in thickness (over the design thickness or minimum thickness specified above, whichever is more). The minimum thickness consideration shall apply for both web and flange.</p> <p>However minimum gusset plate thicknesses shall be followed as mentioned elsewhere in the specification and minimum angle section to be used is ISA 50x50x6. Ends of tubular sections to be effectively sealed at both ends. Also, tubular handrail thicknesses will be as governed by mentioned clauses in the spec</p> <p>Minimum thickness of tubular/ hollow steel sections conforming to IS 4923 shall be 4.0 mm, provided the ends of such steel sections are effectively sealed unless higher thickness is specified elsewhere for specific structure.</p>				
<p>Painting of Steel Surfaces Embedded in Concrete</p> <p>a) For the portion of Steel surfaces embedded in Concrete, the surface shall be prepared by Manual Cleaning and provided with Primer Coat of Chlorinated Rubber based Zinc Phosphate Primer of Minimum 50 Micron Dry Film Thickness (DFT).</p>				
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6.04.03	b) All threaded and other surfaces of foundation bolts and its materials, insulation pins, Anchor channels, sleeves, etc. shall be coated with temporary rust preventive fluid and during execution of civil works, the dried film of coating shall be removed using organic solvents.										
	Painting of Steel Surfaces (Other Than Those Embedded In Concrete)										
	Following painting system corresponding to corrosion category as mentioned in Part A IID Civil Works of this specifications shall be adopted for the project.										
	<table><tr><th>CORROSSIVITY CATEGORY (as per ISO 12944-2)</th><th>PRIMER COAT</th><th>INTERMEDIATE COAT</th><th>FINAL COAT</th></tr><tr><td>CX</td><td>All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer/Zinc rich epoxy coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% ±2%) of minimum 125 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00.</td><td>Primer coat shall be followed with the application of Intermediate coat of low solvent two component amine cured, glass flake reinforced, abrasion resistant epoxy coating with high solids, high build product for better protection in very harsh environment. This coat shall be applied in shop after an interval of minimum 24 hours from the application of primer coat by airless spray technique</td><td>Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 75micron DFT. This coat shall be applied in shop after an interval of minimum 10 hours and within six (6) months from the completion of Intermediate coat. Colour and shade of the coat shall be as mentioned in the colour coding</td></tr></table>				CORROSSIVITY CATEGORY (as per ISO 12944-2)	PRIMER COAT	INTERMEDIATE COAT	FINAL COAT	CX	All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer/Zinc rich epoxy coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% ±2%) of minimum 125 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00.	Primer coat shall be followed with the application of Intermediate coat of low solvent two component amine cured, glass flake reinforced, abrasion resistant epoxy coating with high solids, high build product for better protection in very harsh environment. This coat shall be applied in shop after an interval of minimum 24 hours from the application of primer coat by airless spray technique
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CLAUSE NO.	<div style="text-align: center;">TECHNICAL REQUIREMENTS</div> <div style="text-align: right;"></div>			
<div style="text-align: right; padding-right: 10px;">6.04.04</div> <div style="text-align: right; padding-right: 10px;">6.04.05</div> <div style="text-align: right; padding-right: 10px;">6.04.06</div> <div style="text-align: right; padding-right: 10px;">6.04.07</div>				scheme attached at appendix- I.
	<p>Notes:</p> <ol style="list-style-type: none"> For Primer, high quality surface preparation is necessary and good amount of moisture is required for proper curing. Below 70 % relative humidity, curing time may go up to 7 days or more. In such a case additional water sprinkling may be ensured for completion of curing. Additionally Inorganic zinc silicate cannot be recoated; even with itself. Typically, it should be used when coating bare steel surface for first time. The most frequent problem associated when top coating Primer is bubbling/pinhoing especially with non-weathered zinc silicate coatings. To a great extent, this bubbling of finish paint can be eliminated by applying a mist coat of intermediate/topcoat as the first pass of the product, allow the bubbles to subside and then apply a full coat, as required. In case top coating of zinc silicate with epoxy/polyurethane coatings, is expected to be delayed, it is advisable to use a suitable tie coat to avoid formation of white rust. However, if white rust forms then clean the surface with high pressure water, dry and apply the subsequent coats as required. Touch up paintings on damaged areas: Surface preparation by manual tools, wire brush/ emery paper etc. Minimum 6 inches peripheral area, adjoining to damaged area to be covered. If metal surface is exposed, it is to be painted with Zinc rich epoxy (70 micron) or suitable primer with existing paint scheme. If primer is intact, intermediate & top coat to be done with specified DFT in scheme. 			
	<p>Coating for Mild Steel parts in contact with Water.</p> <ol style="list-style-type: none"> All mild Steel parts coming in contact with water or water vapour shall be hot dip galvanised. The Minimum Coating of Zinc shall be 610 g/ Sq.m. for galvanised Structures and shall comply with IS: 4759 and other relevant Codes. Galvanising shall be checked and tested in accordance with IS: 2629. The galvanising shall be followed by the application of an etching Primer and dipping in black bitumen in accordance with BS: 3416, unless otherwise specified. 			
	<p>Gratings</p> <p>All gratings shall be blast cleaned to Sa 2 ½ finish or cleaned by acid pickling as per ISO 8501-1 and shall be hot dip galvanized at the rate of 610 gm/sqm.</p>			
	<p>Hand Railings and Ladders</p> <p>All Mild steel (MS) handrails and ladders in outdoor locations and in pump valve pits shall be galvanised at the rate of 610 gm/sqm as per IS 4736. All other MS handrails shall be painted as specified in clause 6.04.03 above. However, Stainless steel handrails shall be provided as specified in General Architectural Specification clause 4.00.00.</p> <p>Sea Worthiness</p>			
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6.04.08	All Steel Sections and fabricated Structures, which are required to be transported on sea, shall be provided with anti-corrosive Paint before shipment to take care of sea worthiness.			
6.04.09	Chequered plate to receive same corrosion protection measures as structural steel unless specified otherwise.			
6.04.09	For reinforced concrete work:			
	i) The protection for concrete sub-structure shall be provided based on aggressiveness of the soil, chemical analysis of soil/sub-soil water and presence of harmful chemicals/salts.			
	ii) The protection to super structure shall depend on exposure condition and degree of atmospheric corrosion.			
	This shall require use of dense and durable concrete, control of water cement ratio, increase in clear cover, use of special type of cement and reinforcement, etc., coating of concrete surface, etc.			
6.04.10	For exposed reinforcement:			
	Any exposed portion of reinforcement in RCC works for future use shall be provided with protective coatings, irrespective of any environment exposure condition, in line with cl 5.3.3 of IS 9077.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
6.05.00	GENERAL REQUIREMENTS			
6.05.01	JOINTS IN CONCRETE STRUCTURES			
	Construction Joints			
	All horizontal construction joints shall be provided with a groove (shear key) for transfer of shear force.			
	For construction joint in concrete wall, the maximum height of any lift should not exceed 2 meters. However, the time interval between the successive lifts should be as small as possible and the wall should be built to its full height in the least possible time.			
	Expansions Joints			
	In case of expansion joints, preformed bitumen impregnated fibre board conforming to IS 1838 shall be used as joint filler. The joints shall be sealed with bitumen sealing compound conforming to IS 1834, however in case of liquid retaining/carrying structures, two parts polysulphide sealant conforming to IS 12118 or silicon sealing compound shall be used.			
	IS 3414 shall be followed for details of joints in buildings. 3 mm thick stainless steel strip in matt or buff finish shall be provided over building expansion joints.			
	Construction / Expansion joints for all underground structures shall be made watertight by using ribbed PVC water stops with central bulb or of kicker type. The thickness and width of PVC water stops shall be as per the requirement of design. However, the minimum thickness and width shall be 6mm and 225mm respectively.			
6.05.02	Miscellaneous General Requirements			
	<div>1. All steel sections and fabricated structures, which are required to be transported on sea, shall be provided with anti-corrosive paint before shipment to take care of sea worthiness.</div> <div>2. Monorails, monorail girders and fixtures shall be provided, wherever required to facilitate erection / maintenance of equipment.</div> <div>3. Wherever possible all floor openings shall be provided with 100 mm thick 150 mm high RCC kerb all around.</div> <div>4. Angles 75 x 75 x 6 mm (minimum) with MS lugs of 8mm diameter and 150mm long @ 150 c/c shall be provided for edge protection all around cut outs/openings in floor slabs. Angles 50 x 50 x 6mm with effective anchor lugs shall be provided for edges of concrete drains supporting grating/covers, edges of RCC cable / pipe trenches, supporting cover slabs / chequered plates/ grating, edges of manholes supporting covers, supporting edges of precast RCC covers and any other place where breakage of corners of concrete is expected.</div> <div>5. Floor of switchgear room shall be provided with embedded M.S. channel suitable for easy movement of breaker panels.</div> <div>6. Anti-termite constructional measures and chemical treatment measures shall be given to all areas susceptible to termite including column pits, wall trenches, foundations of</div>			
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	<p>buildings, filling below the floors, etc., as per IS 6313 and other relevant Indian Standards.</p> <p>7. All cable & pipe routing shall be done as per system requirement and as stipulated elsewhere in the specification and shall run above ground on elevated trestles or other supporting structures except in some localized area (as approved by Employer) where the same can run in trenches. In case, pipes are to be routed on RCC pedestals, the height should not be less than 500mm above formation level/paving level. All trenches shall be of RCC with removable RCC covers.</p> <p>All cable trenches located inside buildings shall have minimum 6mm thick (o/p) chequered plate covers.</p> <p>Cable trenches, where allowed, located outside the buildings shall project at least 200mm above the finished formation level unless noted otherwise elsewhere in this specification so that no storm water shall enter the trench. The bottom of the trench shall be provided with a longitudinal slope of 1:500. The downstream end of trenches shall be connected through pipe drains to the nearby RCC manholes (to convey water from trenches) of storm water drainage system, but avoiding back flow of storm water. In general, the precast covers shall not be more than 300 mm in width and shall not weigh more than 65 kg. Lifting hooks shall be provided in the precast covers.</p> <p>All cable trenches, wherever required, shall be provided with suitable insert plates for fixing support angles of cable trays.</p> <p>In Main plant area wherever fire water pipe trenches are envisaged, these trenches shall be of RCC and provided with precast RCC cover flush with finished level of paving in that area.</p> <p>R. C. C. cable slits shall be filled with sand after erection of cables, up to top level and covered with 75mm thick PCC cover of minimum M25 grade.</p> <p>8. All steel platforms above grade shall be provided with 100 x 6 thick kick plates at edge of platform.</p> <p>9. Duct banks consisting of PVC conduits conforming to IS 4985 for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.</p> <p>10. Independent network of lines for sewerage and drainage shall be provided. Plant effluent shall not be mixed with either storm water or sewage.</p> <p>11. The sub-grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor density at Optimum moisture content (OMC.)</p> <p>12. Detailed scheme for dewatering shall be prepared, wherever required, before starting of deep excavation work. IS 9758 shall be followed as general guidance for dewatering.</p> <p>13. Structural steel column base plates and bolts, gussets, etc., shall not project above the floor level unless and noted otherwise. These shall be encased by concrete cover up to floor level with concrete grade M 25 or 75mm above the top of stiffener level whichever is higher.</p> <p>14. Non-shrink flow able grout shall be used for under-pinning work below base plate of columns. Nominal thickness of grout shall be 50 mm. Non-shrink cum plasticizer</p>			
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	<p>admixture shall be added in the grout. Crushing strength of the grout shall generally be one grade higher than that of the base concrete. Minimum grade of grout shall be M-30.</p> <p>Grouting of all pockets, blockouts, sleeves and the openings around the embedment, inserts, bolts etc. and under pinning below the base / sole plate shall be with non - shrink flow able grout. Grade of grout shall be one grade higher than concrete. However minimum grade of grout shall be M - 45.</p> <p>However, for equipment foundations, high strength (minimum characteristic compressive strength of 60 N/sq.mm at 28 days) ready mixed non-shrink, chloride free, cement based, free flowing, non-metallic grout as recommended by equipment manufacturer shall be used.</p> <p>15. All the buildings and site development including landscaping shall be designed to take care of rain water harvesting & ground water recharging. However, if landscaping is excluded from the scope of works, area for landscaping is to be kept.</p> <p>16. As required suitable steel frames shall be provided around openings in the roof and external walls for mounting exhaust fans.</p> <p>17. 750mm wide x 100 mm thick plinth protection in PCC shall be provided around all buildings, pits / sumps, clarifiers, tanks, etc.</p> <p>18. All masonry walls shall be provided with Damp Proof Course at plinth level.</p> <p>19. All monorail openings in the walls shall be provided with double plate flush steel door shutters with suitable access platform and ladder as required.</p> <p>20. Hand rail (of minimum 1m height), size and material to be adopted shall be as per general architectural specification.</p> <p>21. In all buildings, suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, firefighting etc. shall be provided for each floor with suitable floor drains.</p> <p>22. Unless specified all sand filling shall be compacted to minimum 80% of the relative density and backfilled earth shall be compacted to minimum 90% of the Standard proctor density at OMC.</p> <p>23. All buildings shall be provided with peripheral drains by the side of plinth protection for catering to the rain water from roofs and storm water from adjacent area. Plinth protection drains shall be provided all around the building and to be connected with nearest storm water drain. Minimum size of plinth protection drain will be 300mmx300mm.</p> <p>24. Minimum 2.0m wide walkway with plain cement concrete (M25 grade) paving 150 mm thick laid over 75 mm thick bed of dry aggregate shall be provided connecting all buildings and facilities. The top of walkway shall be minimum 200mm above FGL, unless specified otherwise.</p> <p>25. For all buildings, finished floor level (FFL) shall be minimum 500mm above finished ground level (FGL).</p> <p>26. 40mm Diameter MS rods as earthing mat, placed at a distance of 1.0m away and at depths between 0.60m and 1.00m shall be supplied and laid all around the periphery</p>			
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6.05.03	<p>of buildings, structures, and outdoor equipment, as per approved drawings. Riser of 40mm Dia. MS rods and connecting to the above Earthing mat shall also be supplied and laid in position by the Contractor, as per the approved drawings. Raiser shall be laid up to a height of 300 mm above the local Ground level, at each of the columns of the buildings on the outside of the buildings, and minimum 2 (two) numbers for each structures and equipment. The contractor shall also supply and lay necessary number of 3.0 m deep 40 mm diameter MS rods Earthing electrodes and connect electrodes to the Earthing mat, as per the approved drawings and supplying and laying of 40 mm Dia. MS rods for connecting the Contractor's earthing mat with the Employer's earthing mat separately.</p> <p>27. Hume pipes of required class shall be as per IS: 458. Hume pipe made of Geopolymer concrete may also be used. Details of ingredients for Geopolymer concrete is as per details specified elsewhere.</p> <p>28. Coefficient of active earth pressure shall be considered for design of free standing retaining walls and coefficient of earth pressure at rest shall be considered for design of top propped retaining walls.</p> <p>29. Interlocking concrete block confirming to IS:15658, kerb blocks or concrete block specified for various uses shall be precast blocks made of alkali-activated concrete /Geopolymer concrete as per IS:17452- 2020.</p> <p>30. Rail-track from transformer yard to unloading bay of Main Power House shall be provided with rigid type RCC foundation. The rails shall be 52 kg/m Industrial Use (IU) as per Indian Railway Specification IRS T-12.</p> <p>31. All opening in floors/roofs/cladding for routing of pipes/cables/ducts shall be suitably sealed by the contractors after completion of erection works.</p>			
	<p>Acid/ Alkali Resistant Lining</p> <p>All structures receiving acid / alkali resistant lining shall be tested for water tightness and made leak proof before lining work.</p> <p>The acid / alkali resistant lining shall be provided broadly in the areas identified. The Bidder shall give a guarantee for satisfactory functioning of the lining for a period of 36 months from the date of completion of the work or date of handing over the site to the Engineer, whichever is later. The Bidder shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.</p> <p>The material for Acid/ Alkali Resistant Lining shall conform to the following:</p> <p>i) Bitumen primer shall conform to IS: 158.</p> <p>ii) Bitumastic compound shall conform to IS: 9510. Where the height of bitumastic layer on vertical surface is more than 2.0 m, the bitumastic layer shall be reinforced with diamond pattern expanded metal steel sheets conforming to IS: 412.</p> <p>iii) A.R. Bricks/ Tiles shall conform to class II of IS: 4860 & IS: 4457 respectively.</p> <p>iv) Mortar: Potassium silicate & resin type mortars shall conform to IS: 4832 Part-I&II respectively.</p>			
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6.06.00	CONCRETE															
6.06.01	GENERAL															
	<div>a) Concrete work shall be of grade as per IS 456. Mix design concrete shall be used for all areas other than lean concrete work and plain cement concrete where nominal/volume mix can be permitted. Design mix shall be carried out as per IS10262. Specific approval of the Engineer shall be obtained regarding degree of quality control to be adopted for design mix.</div> <div>b) Minimum grade of reinforced cement concrete for all foundations shall be M40 unless noted otherwise. Minimum grade of concrete for other structures/areas (other than machine foundations) shall be M40 for all superstructure and substructure unless noted otherwise elsewhere in this specification. Corrosion inhibiting admixture shall be used in all Reinforced Cement Concrete Works.</div> <div>c) The minimum grades of concrete for different structures, foundations, machine foundations and some of other important structural members shall be as follows::</div> <table><tr><th>Sl No</th><th>Description</th><th>Minimum grade of concrete</th></tr><tr><td>i)</td><td>All Concrete Works</td><td>M40</td></tr><tr><td>vi)</td><td>PCC mat Below foundations</td><td>M25</td></tr><tr><td>viii)</td><td>Road DLC / PQC</td><td>M25/ M40</td></tr></table> <div>d) Higher grade of concrete than specified above may be used at the discretion of the Bidder.</div> <div>e) Unless otherwise specified, 20mm and down aggregates shall be used for all structural concrete works. However, 40mm and down aggregates may also be used under special conditions for mass concreting in foundation.</div> <div>f) For thin concrete sections such as roof slab over profiled metal deck sheets, 12mm and down coarse aggregates shall be used for coarse aggregates.</div> <div>g) Minimum 75mm thick lean concrete M-25 shall be provided below all other underground structures, foundations, trenches, etc., to provide a base for construction.</div> <div>h) All structural(reinforced) concrete production shall be done at automated batching plant of suitable capacity, conforming to IS:4925., situated within the area allocated to the contractor. Batching plant shall also have provision to mix fly ash (by weight). The batching plant shall have facility of digitised recording of the materials added along with quantity of concrete produced in each batch and printout of the same. Batch-wise report for each shift shall be submitted to the Engineer.</div>				Sl No	Description	Minimum grade of concrete	i)	All Concrete Works	M40	vi)	PCC mat Below foundations	M25	viii)	Road DLC / PQC	M25/ M40
Sl No	Description	Minimum grade of concrete														
i)	All Concrete Works	M40														
vi)	PCC mat Below foundations	M25														
viii)	Road DLC / PQC	M25/ M40														
6.06.02	<div>Special requirements for concreting of major equipment foundations shall be as given below.</div> <div>a) Temperature Control of Concrete</div> <div>For all the machine foundations, the temperature of fresh concrete shall not exceed</div>															
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6.07.00		25 deg C when placed. For maintaining the temperature of 25 deg C, crushed ice shall be used in mixing water.		
	b)	Workability		
		The slump shall generally be in the range given below:		
		Block foundations	-	100 mm to 150 mm
		Framed foundations	-	100 mm to 150 mm
	c)	Form work		
		Plywood with film face form work shall be used for the top decks of all machine foundations		
	d)	Placing of Concrete		
		Base Raft and top deck of machine foundations shall be cast in a single pour.		
	e)	Scheme for Concreting		
	Weigh Batching Plants, transit mixer, concrete pump shall be mobilized. Arrangements for standby Plant and Equipment shall also be made.			
f)	Ultrasonic Testing			
	Ultrasonic pulse velocity test shall be carried out for top deck including Columns of framed foundations (in case of Block type, UPV testing is not required) to ascertain the homogeneity and integrity of concrete. In general, grid spacing of 1.0m to 1.5m may be adopted for carrying out the UPV testing. In addition, additional cubes (at the rate of one cube per 150 Cum of concrete subject to a minimum of six cubes) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes, to serve as reference UPV values. Testing shall be done as per IS 516 Part-5, Sec-I. In case of any defect, the Bidder shall rectify the defects suitably using cement/epoxy grout, etc.			
	Wherever block type foundations are provided for machine foundations, UPV testing of foundation concrete is not required.			
	FORMWORK			
	Formwork for building RCC Slabs/ Beams & Columns shall be of 2 different types.			
	Type 1 Formwork: (For RCC slab of Structural Steel Framed Buildings Only)			
	Troughed colour coated metal deck sheets shall be used as permanent shuttering having minimum thickness as per the criteria specified in metal deck roof material clause in Architectural Design and concept chapter and design criteria chapter. These profiled metal deck sheets shall be fixed to the structural steel secondary beams/ Purlins using Headed shear anchor studs.			
	The shear anchor studs for fixing metal deck sheet to floor structural beams shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 19mm diameter and 100mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.			
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	<p>The shear anchor studs for fixing metal deck sheet to roof structural purlins shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 16mm diameter and 65mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.</p> <p>Type 2 Formwork: (For RCC Buildings)</p> <p>Plywood with film face formwork shall be used for floor & roof slabs, Columns & Beams of all RCC buildings.</p>			
6.08.00	DELETED			
6.09.00	FENCING AND GATE			
6.09.01	FENCING			
	<p>Fencing with gate shall be provided around fuel oil area, and other areas wherever necessary due to security, safety, and statutory requirements as per following specifications. However, for isolation between existing station/township and the project, the total height of fence may be reduced to 2.4m with 450mm barbed wire on top, while other details being same as given below.</p> <p>The fencing, with gate (unless specified otherwise) shall comprise of PVC coated G.I. welded wire mesh fencing of minimum 4 mm diameter (including PVC coating) of mesh size 75mmX75mm of height 2.4m above the toe wall with a 600mm high galvanised concertina at the top, such that total fence height of 3.0m above the toe wall is achieved. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 2.5 mm.</p> <p>The PVC coated chain link will be stretched by the clips at 0.5m intervals to three strands of galvanised high tensile spring steel wire (HTSSW) of 2.5 mm diameter interwoven with chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip will be threaded through the links of chain link and bolted to the fence post with the help of security nuts and bolts.</p> <p>Above the chain link a 600mm high tensile serrated galvanised wire (HTSW) concertina made with wire diameter of 2.5mm will be stretched to 6m and attached to two strands of galvanised HTSSW of 2.5 mm diameter by means of clips at 1m intervals. These two HTSSW strands will be attached to the fence posts with 12 mm security fasteners.</p> <p>All nuts, bolts, fasteners, clamping strips, clamps, clips, etc., shall be galvanised.</p> <p>All fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5m c/c distance. All corner posts will have two stay posts and every tenth post will have transverse stay post. Suitable R.C.C. foundations for the post and stays shall be provided based on the prevailing soil conditions. All posts of fencing shall be painted with chlorinated rubber paint over a suitable primer.</p> <p>Toe walls either of brick masonry with bricks of minimum 50 kg./sq.cm. Crushing strength or of hollow concrete block masonry shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200mm above the formation level with 50mm thick P.C.C. coping (1:2:4) and shall extend minimum 300mm below the formation level. Toe wall shall be plastered with cement sand mortar (1:6) on both sides and</p>			
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6.09.02	shall be painted with two coats of textured cement point of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacing.			
	Gate along Fencing			
	All gates shall be of structural steel of minimum 3.75 metre width for single lane access road and 8.00 m width for double lane access roads. The height of gate shall be same as that of the fence unless noted otherwise. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m.			
6.10.00	The gate frame and post shall be fabricated from medium class MS pipe of nominal diameter not less than 75 mm. The panel plate shall be of minimum thickness 2.5 mm conforming to IS: 513.			
	The gate shall be complete with fabricated hinges, MS aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminium ball bearing arrangement, castor wheel, etc.			
	GRATING			
6.11.00	All gratings shall be electroforged types. Minimum thickness of the grating shall be 40 mm The opening size shall not be more than 30mmx100mm. The minimum thickness of the main bearing bar shall be 5 mm or as per design requirement whichever is higher. All gratings shall be hot dip galvanised at the rate of 610 g. per sq.m. after surface preparation by means of shot blasting or cleaned by acid pickling.			
	FABRICATION & ERECTION OF STEEL STRUCTURES			
	The fabrication shall be done as per fabrication drawing which would clearly indicate various details of joints to be welded, type of weld, length and size of weld.			
6.11.01	Also refer Part-A IID, cl 1.00.01 for fabrication of steel structures.			
	Site welding can be permitted in special cases where final inputs are not available before release of fabrication drawings.			
	Before dispatching the fabricated structural members to site, it shall be ensured that all parts in the assembly fit accurately together by carrying out pre-assembly of fabricated structural members having bolted field joints, in the factory.			
6.11.01	All steelwork before and after manufacturing shall be smooth, straight and free of deformations, cracks, twists and burrs. All steelwork shall be cut and fabricated to a tolerance of ± 1.5 mm in its length and location of matching bolt holes for field connections.			
	Welding			
	For Welding, refer relevant Quality Assurance chapter/s of the Technical Specification.			
6.11.01	Sequence of Welding			
	a) The sequence of welding shall be carefully chosen to ensure that the components assembled by welding are free from distortion and large residual stresses are not developed. The distortion should be effectively controlled either by a counter effect or			
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	<p>by a counter distortion. The direction of welding should be away from the point of restraint and towards the point of maximum freedom.</p> <p>b) Each case shall be carefully studied before finally following a particular sequence of welding.</p> <p>c) Butt weld in flange plates and/or web plates shall be completed before the flanges and webs are welded together.</p> <p>d) The beam and column stiffeners shall preferably be welded to the webs before the web and flanges are assembled unless the web and flanges to the beam or column are assembled by automatic welding process.</p> <p>e) All welds shall be finished full and made with correct number of runs, the weld being kept free from slag and other inclusions, all adhering slag being removed.</p> <p>f) Current shall be appropriate for the type of electrode used. To ensure complete fusion, the weaving procedure should go proper and rate of arc advancement should not be so rapid as to leave the edges unmelted.</p> <p>g) Pudding shall be sufficient to enable the gases to escape from the molten metal before it solidifies.</p> <p>h) Non-uniform heating and cooling should be avoided to ensure that excessive stresses are not locked up resulting ultimately in cracks.</p> <p>i) The ends of butt welds shall have full throat thickness. This shall be obtained on all main butt welds by the use of run off and run on pieces adequately secured on either side of main plates. The width of these pieces shall not be less than the thickness of the thicker part joined. Additional metal remaining after the removal of extension pieces shall be removed by grinding or by other approval means and the ends and surface of the welds shall be smoothly finished. Where the abutting parts are thinner than 20mm the extension pieces may be omitted but the end be welded to provide the ends with the required reinforcement.</p> <p>j) The fusion faces shall be carefully aligned. Angle shrinkage shall be controlled by presetting. Correct gap and alignment shall be maintained during the welding operation.</p> <p>k) All main butt welds shall have complete penetration and back surface of the weld being gouged out clean before first run of the weld is given from the back. However, partial penetration butt weld shall be permitted, when specifically shown in the design drawings.</p> <p>l) Intermittent welds shall be permitted only when shown in the design drawings.</p> <p>m) The welding shrinkage shall be minimised by adopting the correct welding procedure and method. In long and slender member extra length should be provided at the time of fabrication for shrinkage.</p> <p>6.11.02 Painting</p> <p>a) Surface treatment and painting before and after delivery to site shall be in accordance with Clause no. 6.4.0 above. All steel structures shall be designed by following basic</p>		
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6.11.03	<p>design criteria in ISO 12944 Part 3. However, where it is not feasible to follow the design criteria given in ISO 12944 Part 3 where the steel surface are inaccessible for application of protective coating, corrosion allowance in thickness(over the design thickness) of structural steel members shall be kept.</p>			
	<p>b) For parts to be bolted, the surfaces in contact shall be provided with ethyl Zinc silicate primer as specified in clause 6.4.3 (a) and shall be free of oil, dirt, loose rust, burrs and other defects, which would prevent proper seating of the parts. For design of friction type bolted joints slip factor for surfaces with ethyl zinc silicate primer as given in IS 4000 shall be considered.</p> <p>c) Surfaces inaccessible after shop assembly shall receive the full-specified protective treatment before assembly. However, interior surfaces of Box-sections, which are effectively sealed from all ends, need not be painted.</p>			
6.11.03	<p>Bolting</p> <p>The threaded portion of each bolt shall project through the nut by at least one thread. High strength friction grip bolts, preferably the type with indicated load, shall be used where specified and shall be tightened strictly in accordance with the manufacturer's instructions and the relevant regulations. When connections are made using high strength friction grip bolts, relevant standards shall be observed.</p> <p>For the bolts supplied in dull-black condition, exposed portion of bolts, nuts etc shall be painted immediately after bolting with primer, intermediate & top coat in line with touchup painting cl 6.04.03. For bolts supplied in Galvanized or Aluminum/ Zinc-spray coated condition, this painting need not be done.</p>			
6.11.04	<p>Erection of Structures</p> <p>All erection work shall be done with the help of cranes, use of derrick is not envisaged.</p> <p>Erection Marks</p> <p>a) Erection marks in accordance with fabrication drawing shall be clearly painted on the fabricated steelwork. Each piece shall be marked in at least on two places. Each piece shall also have its weight marked thereon.</p> <p>i) The centre lines of all columns, elevations and girder bearings shall be marked on the sections to ensure proper alignment and assembly of the pieces at site.</p> <p>Erection Scheme</p> <p>a) The Erection Scheme for the erection of all major structures shall be furnished. The erectability of the structure shall be checked by the Bidder before commencement of fabrication work to avoid future modification. The erection scheme shall indicate the approximate weight of the structural members, position of lifting hook, crane boom length, crane capacity at different boom length and at different boom inclination, etc.,</p> <p>b) The erection scheme shall also give details of the method of handling, transport, hoisting, including false work/staging, temporary, bracing, guying, temporary strengthening, etc., It will also give the complete details of the number and capacity of</p>			
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	<p>the various erection equipment that will be used such as cranes, winches, etc., along with disposition at the time of erection of columns, trusses, etc.</p> <p>c) The erection of columns, trusses, trestles, portals, etc., shall be carried out in one single piece as far as practicable. No column shall be fabricated and erected in more than 3 pieces. Galleries shall generally be erected as box i.e. the bottom chord and bracings, top chord and bracings, side vertical posts and bracings, end portals and roof-trusses shall be completely welded prior to erection and if required temporary strengthening during erection shall be made. The inside sheeting runners and roof sheeting purlins may be erected individually. When erection joints are provided in columns, their location shall generally be just above a floor level.</p>		
6.12.00	STEEL HELICAL SPRINGS AND VISCOUS DAMPERS UNITS		
6.12.01	General Requirement		
6.12.02	<p>This part of the specification covers the requirement for the manufacturing, testing, supply, transport to site, pre-stressing erection, supervision of erection by the vendor, release of pre-stress, alignment, commissioning, etc. of Steel helical springs and viscous dampers units.</p> <p>The Steel helical springs and viscous dampers units supplied should be of proven make.</p>		
	<p>Codes and Standards</p> <p>Some of the relevant applicable Indian standards and codes, etc, applicable to this section of the specification are listed below:</p> <p>DIN : 4024 Machine foundations; Flexible supporting structures for machine with rotating masses.</p> <p>DIN : EN 13906-1 Cylindrical helical springs made from round wire and bar: calculation & design.</p> <p>DIN : 2096 Helical compression springs out of round wire and rod; quality requirements for hot formed compression springs.</p> <p>ISO : 10816 /IS:14817 Criteria for assessing mechanical vibrations of machine.</p> <p>ISO : 1940/IS: 11723 Criteria for assessing the state of balance of rotating rigid bodies.</p>		
6.12.03	<p>Design & Supply of Material</p> <p>i) Supply</p> <p>Steel helical springs and viscous dampers and associated auxiliaries shall consist of:</p> <p>(a) Steel helical springs units (fully pre-stressable) and viscous dampers units along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads, etc.</p> <p>(b) Frames for pre-stressing of spring elements.</p> <p>(c) Suitable hydraulic jack system including electric pumps, high pressure tubes etc. required for the erection, alignment etc., of the spring units. One set of</p>		
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6.12.04	<p>extra hydraulic jacks, and hand operated pumps shall also be provided.</p> <p>(d) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment, and commissioning of the Steel helical springs and viscous dampers.</p> <p>ii) Design</p> <p>The spring units should have stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 50% of vertical stiffness. However, for projects in high seismic zones, the minimum stiffness in horizontal direction shall be reviewed based on the design requirement and in no case it shall be less than 15% of vertical stiffness.</p> <p>The stiffness should be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is between 2 Hz to 4 Hz. The damper units or spring-cum-damper units should be of viscous type offering velocity proportional damping. The damper units should be suitable for temperatures ranging from 0 to 50°C. The damping resistance of individual damper units should be such that the designed damping can be provided using reasonable number of Units.</p> <p>The Steel helical spring units and viscous damper units and their housings shall be designed for a minimum operating life of 30 years. Steel helical spring units shall conform to infinite life fatigue load calculations as per DIN EN 13906-1.</p>			
	<p>Manufacturing & Testing</p> <p>Complete manufacturing and testing of the Steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub vendor / supplier. For this purpose the contractor / sub vendor shall submit the detailed quality plan for approval of engineer and take up the manufacturing / testing after approval of such quality plan. The quality plan shall include</p> <p>(a) Manufacturing schedule and quality check exercised during manufacturing.</p> <p>(b) Detail of test to be carried out at the manufacturing shop with their schedule.</p> <p>(c) Special requirements, if any, regarding concreting of top deck.</p> <p>(d) Complete step-by-step procedure covering the installation and commissioning of the spring system.</p> <p>(e) Manuals for erection, commissioning, testing and maintenance of the Steel helical springs and viscous dampers.</p> <p>(f) A checklist for confirming the readiness of the civil fronts for erection of Steel helical springs and viscous dampers.</p> <p>(g) Checklist for equipment required at each stage of erection.</p> <p>(h) Bill of materials and data sheet of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.</p> <p>(i) Bill of material and data sheet for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc., with their rating and</p>			
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	umbers.			
	(j)	Any other details which may be necessary to facilitate design and construction of the foundations / structures.		
6.12.05	The springs shall conform to codes DIN EN 13906-1 and DIN 2096. The quality assurance and inspection procedure shall be finalized on the basis of the above codes and the quality plans be drawn accordingly.			
6.12.06	Transportation Steel helical springs and viscous dampers shall be suitably protected, coated, covered, boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection.			
6.12.07	Erection and Commissioning Complete erection and commissioning of the Steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre-stress in spring elements, making final adjustments and alignments etc. shall be carried out by a specialist supervisor of vendor. The contractor shall guarantee the performance of the Steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as Guarantee Period”.			
6.12.08	Supervision The supervision of installation of Steel helical springs and viscous dampers including pre-stressing, placing, releasing and alignment of spring units shall be done by a specialist supervisor of sub vendor / supplier, trained for this purpose. 1. Realignment of Spring System If any realignment of the Steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of commissioning of the machine, the same shall be done by the contractor. 2. Acceptance Criteria Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096. Following acceptance criteria shall be followed: General workmanship is being good as recommended by the manufacturer and approved by Equipment supplier. Tolerances are within the specified limit.			
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	<p>Manufacturer's test certificate (MTC) shall be in compliance with the applicable codes / standards.</p> <p>Bought out material is from the approved manufacturer / vendor.</p> <p>Bought out material is matching with the approved sample.</p>			
6.13.00	DELETED			
6.14.00	DELETED			
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<div> D-1-7 </div> <div> 7.00.00 </div> <div> 7.01.00 </div> <div> 7.02.00 </div> <div> 7.03.00 </div>	<div> MATERIAL SPECIFICATION </div> <div> Cement </div> <div> <p>Fly ash based portland pozzolana cement conforming to IS: 1489 (Part-1) shall be used for all areas other than for the critical structures identified below. Other properties shall be as per IS code.</p> </div> <div> <p>Ordinary Portland Cement (OPC) shall necessarily be used for the following structures.</p> </div> <div> <ul style="list-style-type: none"> a) Chimney shell b) Framed Foundations </div> <div> <p>The grade of cement shall be Grade 43 for OPC conforming to IS: 269.</p> </div> <div> <p>In place of fly ash based portland pozzolana cement, OPC mixed with Fly Ash can be used. Batching plant shall have facility for mixing fly ash. Fly ash shall conform to IS: 3812(Part I). Percentage of fly ash to be mixed in concrete shall be based on trial mix. Mix design shall be done with varying percentage of fly ash mix with cement</p> </div> <div> <p>Usage of special cement and / or concrete coatings as suggested in IS 456 can also be used.</p> </div> <div> Aggregates </div> <div> a) Coarse Aggregate </div> <div> <p>Coarse aggregate for use in concrete shall meet the requirements of IS: 383.</p> </div> <div> <p>However, use of aggregate manufactured from other than natural sources (Listed in Annexure-A of IS 383) and Bottom Ash from Thermal Power Plants shall be permitted only in Lean Concrete of Grade M7.5 and M10 (for % of utilization refer Table-1 of IS 383).</p> </div> <div> b) Fine Aggregate </div> <div> <p>Fine aggregate shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Fine aggregate in concrete shall conform to IS: 383. Bidder can use either natural sand or crushed sand, confirming to IS:383, based on availability.</p> </div> <div> <p>For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116.</p> </div> <div> <p>However, use of aggregate manufactured from other than natural sources (as Listed in Annexure-A of IS 383) and Bottom Ash from Thermal Power Plants conforming to IS:383 shall be permitted only in Lean Concrete of Grade M7.5 and M10 (for % of utilization refer Table-1 of IS 383).</p> </div> <div> Reinforcement Steel </div> <div> <p>Reinforcement steel shall be of high strength deformed TMT corrosion resistant grade steel</p> </div>		
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<div>7.04.00</div> <div>7.04.01</div> <div>7.04.02</div>	<p>bars of grade Fe-415/Fe-500/Fe 500D/Fe550D and shall conform to IS 1786 and IS 13920. However, minimum elongation shall be 14.5%.</p> <p>Relevant clause of IS 13920 are quoted below for clarity:</p> <p>Quote</p> <p>5.3.1 Steel reinforcement shall comply with all of the following:</p> <ol style="list-style-type: none"> Elongation shall be at least 14.5 percent, Ratio of ultimate stress to 0.2 percent proof stress shall not exceed 1.25, Ratio of ultimate stress to 0.2 percent proof stress shall be at least 1.15, and Steel shall be only of strength grades with minimum 0.2 percent proof stress of 415 MPa, 500 MPa or 550 MPa, in addition to other requirements of IS 1786.' <p>5.3.2 The actual 0.2 percent proof stress of steel bars based on tensile test must not exceed their characteristic 0.2 percent proof stress by more than 20 percent</p> <p>Unquote</p> <p>Mild steel and medium tensile steel bars shall conform to Grade A of IS:432-Part 1 and hard drawn steel wire shall confirm to IS:432-Part II. Welded wire fabric shall conform to IS 1566.</p> <p>Structural Steel</p> <p>Structural Steel (including embedded Steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects. Structural steel shall comprise of mild steel, medium strength steel and high tensile steel as specified below.</p> <p>Mild Steel</p> <ol style="list-style-type: none"> Rolled sections shall be of grade designation E250, Quality A/BR, Semi-killed/ killed conforming to IS 2062. All steel plates shall be of Grade designation E250, Quality BR (fully killed), conforming to IS 2062 and shall be tested for impact resistance at room temperature. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2. Pipes shall conform to IS: 1161. Hollow (square and rectangular) steel sections shall be hot formed conforming to IS: 4923 and shall be of minimum Grade Yst 240 and minimum thickness shall be 4 mm.. Chequered plate shall conform to IS 3502 and shall be minimum 6 mm thick excluding projection. Steel for chequered plate shall conform to grade E250A semi killed of IS: 2062 or equivalent grade conforming to ASTM & BS standards only. <p>Medium and High Tensile Steel</p> <p>Rolled Sections and plates shall be of grade designation E350 or higher, Quality B0 (Fully killed), conforming to IS: 2062. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.</p>		
	<div> GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE </div> <div> TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-6401-001-2 </div> <div> SUB-SECTION-D-1 CIVIL WORKS </div> <div> PAGE 100 OF 103 </div>		

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7.05.00	Bricks Only fly ash bricks shall be used in all construction, except for elevator shafts, which can be either of burnt clay bricks or RCC construction as per functional / codal provisions. Bricks shall be table moulded/ machine made of uniform size, shape and sharp edges and shall have minimum compressive strength of 75kg/cm2. Burnt clay fly ash bricks conforming to IS: 13757, or Fly ash lime bricks conforming to IS: 12894 or Fly ash Cement Brick conforming to IS 16720 shall be used. Minimum fly ash content in fly ash based bricks shall be 25%.			
7.06.00	Foundation Bolts Material and details of foundation bolts shall conform to IS: 5624. Mild steel bars used for the fabrication of bolt assembly shall conform to grade 1of IS: 432 and/ or grade A of IS: 2062. Hexagonal nuts and lock nuts shall conform to IS: 1363 & IS: 1364 upto M36 diameter and IS: 5624 for M42 to M150 diameter.			
7.07.00	Stainless steel The material specification for stainless steel plates are mentioned in the design concept area of Mill Bunker building.			
7.08.00	Water Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregate, soaking of bricks, etc. shall be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for all masonry and concrete works, including curing. When water from the proposed source is used for making the concrete, the maximum permissible impurities, development of strength and initial setting time of concrete shall meet the requirements of IS: 456. All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.			
7.09.00	PTFE (Poly Tetra Fluoroethylene) Bearing The bearing shall be of reputed make and manufacturer as approved by the Engineer, for required vertical load and end displacement/rotation. 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/sq.cm. In order to prevent cold flow in PTFE surface it shall be rigidly bonded by a special high temperature resistance adhesive to the stainless steel substrata. The stainless steel surface that 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 stainless steel plate shall be between 1.0 mm to 1.5 mm.			
7.10.00	Autoclave Aerated Concrete (AAC) block			
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	<p>Providing and laying of Autoclave Aerated Concrete (AAC) block masonry using blocks having dimensions of 600mm x 250mm. thickness ranging from 100 mm to 300 mm conforming to IS:2185 (Part-III), for dimension and tolerance, with minimum compressive strength of 30 kg/ sq.cm. The jointing cement sand mortar in the composition of 1:6 (Cement: Sand) shall be used with suitable plasticizer (optional). Sand having modulus of fineness 1.1 shall be used. The horizontal and vertical joint thickness shall be approximately 10 mm. In case of partition walls (1000 mm/ 125 mm thk.) the jointing reinforcement i.e 1 number of 8 mm diameter bars shall be placed at every alternate course to be anchored properly with the main structure. All other structural requirements like stiffening of masonry, joint reinforcement etc. in the AAC masonry work strictly be carried out as per instruction laid down in IS:6041-1985, IS-1905).</p> <p>AAC blocks shall have the following physical properties:</p> <p>Density (oven dry) - 550-650kg/ cum. Compressive Strength - Min. 30 kg/ sq. cm. Thermal Conductivity - 0.162W/mk (avg) Resistant to fire - 2-6 hrs depending upon thickness Dry shrinkage - 0.02% (avg) Design gross density - 800 kg/cum (approx)</p>			
7.11.00	<p>Polystyrene</p> <p>Polystyrene board shall be of type-1 conforming to IS 4671 with minimum bulk density of 20 Kg/cum (allowable tolerance as specified in IS 4671).</p>			
7.12.00	<p>Chemical Admixtures</p> <p>All Chemical Admixtures shall conform to IS 456. Any special admixtures shall conform to either IS 9103 or ASTM C-494. Admixtures shall be used in liquid form only, quantity of which shall be as per manufacturer's recommendation and approved mix design.</p>			
7.12.01	<p>Chemical Admixtures for workability</p> <p>PCE type Super-plasticizers shall only be used in concrete mix, wherever required.</p>			
7.12.02	<p>Chemical Admixtures for corrosion inhibition</p> <p>Corrosion inhibiting admixture (Organic Bipolar concrete penetrating admixture type), shall be used in concrete, for corrosion inhibition, and shall conform to tests specified in RDSO specification number M&C/PCN/126.</p>			
7.12.03	<p>Chemical Admixtures for waterproofing</p> <p>Integral Crystalline admixture, if used in concrete, for waterproofing treatment to Concrete shall comply with CPWD specification 2019, clause 22.14.</p>			
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CLAUSE NO.	<div> TECHNICAL REQUIREMENTS </div> <div> </div>		
<div> 7.13.00 </div> <div> 7.14.00 </div>	<div> Reinforcement Couplers </div> <div> <p>Reinforcement couplers (mechanical splicing systems with upset parallel threaded couplers) may be used in reinforced concrete works, subject to following conditions:</p> </div> <div> <ul style="list-style-type: none"> a. Couplers and splice shall meet the performance requirements of IS 16172 for class H. b. The minimum clear cover requirements are to be ensured for reinforcement couplers also. c. The couplers shall be used only at the locations where joint is required as per standard lapping purpose and couplers shall not be used for joining of several cut pieces of reinforcement in a single bar. As a general guideline, the length of the bars in which coupler is to be provided should not be less than 4m. </div> <div> Anchor Fasteners </div> <div> <p>Anchor Fasteners for use in concrete shall conform to IS 1946. Further, Anchor fastener shall be designed considering seismic conditions also. Concrete shall be considered as Cracked concrete for design consideration.</p> </div> <div> <p>Minimum size of the anchors shall be M8.</p> </div> <div> <p>Mechanical type: The anchors shall be cold formed stud type torque controlled mechanical expansion GI fasteners having sleeve with nut and washer and galvanized to minimum 5 microns. For coastal/ corrosive environments, the anchors shall be of Stainless Steel (min grade SS 316) or HCR (High Corrosion Resistance). The anchors shall conform to a minimum grade of 5.8 as per IS: 1367.</p> </div> <div> <p>Chemical type: The anchor shall be adhesive type consisting of slow curing chemical adhesive with a proportion of resin and hardener as per manufacturer's recommendation, threaded rod of carbon steel conforming to a minimum grade of 5.8 as per IS: 1367 and minimum galvanization of 5 microns with associated nut and washer.</p> </div> <div> <p>Scanning before drilling to be done with Concrete scanner/ Rebar scanner to have safe drill location and avoid rebar hits.</p> </div>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-6401-001-2	SUB-SECTION-D-1 CIVIL WORKS	PAGE 103 OF 103

TECHNICAL SPECIFICATIONS

D-1-8

PRE-ENGINEERED BACHELOR AND SUITE ACCOMMODATION

(G+1 STOREY PRE-ENGINEERED STRUCTURE)

1.00.00 INTENT OF SPECIFICATION

1.00.01 The intent of the specification is to provide technical guidelines for execution of **PRE-ENGINEERED BACHELOR AND SUITE ACCOMMODATION (16 SINGLE ROOM , 6 SUITE ROOM ACCOMMODATION , DINING , KITCHEN , STORE, UTILITY, HALL, LOUNGE , RECEPTION) GNI PROJECT.**

1.00.02 The technical specification includes all civil, structural, architectural services, electrification works, fire detection and protection works, air conditioning works etc to be executed by the bidder. The works shall have to be carried out both below and above ground level. The works shall be carried out within the township/ plant boundaries provided by OWNER unless otherwise specified.

1.00.03 The bidder is expected to get all doubts clarified in respect of interpretation of any portion of these documents before tendering, in writing with the owner.

2.00.00 LOCATION

The site of the proposed **PRE-ENGINEERED ACCOMMODATION** shall be located in the provided area. The Natural Ground Level and Formation level of the proposed location are determined with the approval of Engineer-in-charge.

3.00.00 SCOPE OF WORK

3.00.01 The scope of work includes the design, Engineering, supply, installation, successful commissioning and handing over of **Pre-Engineered Accommodations at GNI Project** consisting of bedrooms/rooms along with attached toilets, corridor and reception cum entrance lobby , Dining , Kitchen , Utility (**G+1 Storeyed structure with 1600 sqm. Built up area**) including RCC foundation for the pre-engineered structure, with footings, columns, plinth beams and Brick work etc. up to plinth, super structure with structural steel, staircase, walls, intermediate slab, roofing and false ceiling, insulation, flooring, skirting and dado, service platforms, doors and windows, sanitary installations, plumbing, sewerage, drainage, electrification, fire detection and protection system, air conditioning system, plinth protection, anti – termite treatment, pathway and surface drains, water storage tank with necessary support structure, approach Road and area development as per the schematic plan shown in Tender drawings and technical specifications.

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- 3.00.02** All work shall be performed in accordance with tender drawings, technical specifications, schedule of items other tender documents and directions of the Engineer-in -charge. Item /items of work though specified in the Schedule of items for which detailed specifications are not given in the technical specifications, shall be performed as per CPWD Specifications and/or best available industry practices.
- 3.00.03** The bidder shall inspect the site and shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.
- Accordingly detailed engineering/ architectural design based on tender drawings shall have to be carried out by bidder taking into considerations the requirements submitted with the tender. The successful bidder shall have to get the structural design done as per the prevailing IS codes.
- 3.00.03** The detailed structural design and drawings including foundation support system by bidder shall have to be duly vetted by NIT/IIT. Stability reports shall also be duly examined and issued by NIT/IIT. The vetted design, drawings and stability reports shall be submitted to owner and clearance obtained before commencement of work at site. The rate quoted by the bidder shall deem to include design charges and expenditures to be incurred by the bidder on account of vetting.
- 3.00.05** The successful bidder shall have to construct the complete facility within the stipulated time; testing and commissioning of the whole project shall have to be carried out to the satisfaction of Engineer-in -charge.
- 3.00.06** The successful bidder shall have to give one year free comprehensive guarantee for maintenance and repair for all above mentioned works. The bidder shall have to keep agency for maintenance & repairs for the prescribed period.
- 3.00.07** The successful bidder shall have to give shop drawing of all works for acceptance of OWNER before starting the execution of item.
- 3.00.08** **Construction Facilities**
- The following are also in the Bidder's scope of work pertaining to construction facilities for the package.
- (1.) All necessary fire fighting devices/ equipment/ fire tender etc. required for

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safety purpose during the project execution stage.

(2.) All tools and tackles required for the work.

(3.) Bidder shall arrange skilled/ semiskilled/ unskilled labour from local sources as far as available and supervisory staff for quality execution of all works.

(4) All construction materials including cement, reinforcement steel, coarse & fine aggregate, structural steel, bricks, wall & roof panels, all finishing items, electrical items, mechanical works items, plumbing, drainage, sewerage items etc., shall be arranged by the Bidder.

(5.) Earthwork in cutting and/or filling required to achieve the specified Finished Ground Level (FGL) shall be in the scope of the bidder. Filling shall be done either with excavated earth or good earth/moorum/sand arranged by the bidder himself. Nothing extra shall be payable on this account.

4.00.00 GENERAL GUIDELINES

4.00.01 All building design shall be as per latest NBC Guidelines (For Lighting, Ventilation, Space requirement, Fire norms etc).

4.00.02 All buildings shall be designed incorporating the provisions for barrier free environment for physically disabled persons (Provision of ramp & specially designed toilets as per norms.

5.00.00 CIVIL WORKS:

The broad subdivision of scope of work is given as under, for general understanding. However, this in no way limits the work for successful completion and commissioning of the facilities.

Design, Engineering, Supply, Transportation, Installation and commissioning of the pre-engineered Accommodations including foundation support system and plinth, structural steel framed super-structure, walls, roofing, false ceiling, insulation, flooring, skirting and dado, service platforms, doors and windows, sanitary installations and plumbing, drainage, sewerage, anti-termite treatment, plinth protection with drain, disposal/backfilling of surplus excavated earth and area development as per the Tender drawings, technical specifications and instruction of Engineer-in charge with one year comprehensive maintenance and repairs guarantee.

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5.01.00 SUB STRUCTURE

5.01.01 The foundation design shall be done and appropriate ground improvement shall be carried out based on the geotechnical investigation and as per relevant IS codes.

The soil data furnished is in good faith and only for guidance of bidder. Owner shall not entertain any claim, whatsoever, on account of variation of subsoil data actually encountered during execution with respect to the subsoil data enclosed with this document. Bidder shall judiciously design foundation support system considering actual nature of soil and the safe bearing capacity of the soil as per site conditions and as approved by engineer-in-charge.

All foundation arrangements like RCC footings, columns, pedestals, plinth beams, brickworks etc shall be provided. All works like necessary excavation, PCC, backfilling, compaction, etc upto FGL to support the superstructure conforming to relevant Indian standards on the basis of soil investigation shall be done.

5.01.02 Foundation System

(a.) All structures shall be supported on suitable open foundations (isolated, combined, raft).

(b.) No foundation shall rest on the filled up ground / soil.

(c.) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards. The water table for design purpose shall be considered at Finished Ground Level (FGL).

(d.) The minimum width of foundation shall be 1.0m and min. depth of foundation shall be 1.5m below natural ground level.

5.01.03 The plinth level shall be as per tender drawings from the formation level i.e highest ground level of plot for the structure. Filling in the plinth shall be with minimum 100mm thick RCC grade slab (1:1.5:3 DSR item no. 5.1) with required reinforcement over 150mm compacted sand filling. Necessary earth shall be filled and compacted below sand layer. Locally available sand may be used for filling below plinth.

The top of plinth beam shall be at plinth level and shall be supported on suitable brickwork foundation upto a depth of min. 500mm below ground level.

5.01.04 Minimum nominal reinforcement (0.12% of total cross sectional area in each direction) shall be provided at the top face of the footing, even if, no reinforcements are required as per design

The minimum grade of concrete to be used in foundation works shall be M25 or complying to IS 456 and grade of reinforcement steel shall be TMT steel bars of grade Fe-415/Fe500/Fe 500D/Fe550D and shall conform to IS 1786.

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5.01.05

Anti – termite treatment is to be provided by the bidder (As per DSR Item No. 2.34.1 and corresponding CPWD specifications). The work includes

Diluting and injecting chemical emulsion for Pre- constructional anti-termite treatment and creating a continuous chemical barrier under and around the column pits, walls, trenches, basement excavation, top surface of plinth filling, junction of wall and floor, along the external perimeter of building, expansion joints, over the top surface of consolidated earth on which apron is to be laid, surroundings of pipes and conduits etc. complete as per specifications, using Chlopyriphos / Lindane E.C.20% with 1% concentration.

Specifications of Chemicals and its safety precautions are to be followed as CPWD Specifications of DSR for anti-termite treatment.

(i) Pre-construction Chemical Treatments

Chemical treatment of soils for the protection of buildings from attack of subterranean termites shall be done as per IS: 6313 (Part II).

Graduated containers shall be used for dilution and spraying of the chemical shall be done using hand operated pressure pumps. Proper check should be kept to ensure that the specified quantity of chemical is used for the required area during the operation.

(ii) Time of application

Soil treatment should start when foundation trenches and pits are ready to take bed concrete / levelling course in foundations. Laying of bed concrete / levelling course should start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or soil is wet with rain or sub soil water. Treatment to the surface of earth filling within the plinth shall also be done in the same manner before laying the sub-grade for flooring.

(ii) Disturbance:

The treated soil barrier shall not be disturbed. If for some reasons the treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

(A) Treatment for Masonry Foundation & Basements

(a) The bottom surface and the sides (up to a height of 300 mm) of the excavations made for masonry foundations and basements shall be treated with the chemical at the rate of 5 litres per square meter surface area (As shown in figure below).

(b) After the masonry foundations and the retaining wall of the basements come-up, the backfill in the immediate contact with the foundation structure

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shall be treated at the rate of 7.5 litres per sqm of the vertical surface of the substructure for each side.

If water is used for ramming the earth fill, the chemical 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 chemical with the above dosage. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surfaces is well treated with the chemical.

(B) Treatment for RCC Foundation and Basements

In the case of RCC foundations, the concrete mix is dense (being 1:2:4 or richer). It is, therefore, unnecessary to start the treatment from the bottom of excavations. The treatment shall start at the depth of 500 mm below ground level except when such ground level is raised or lowered by filling or cutting after the foundations have been cast. In such cases, the depth of 500 mm shall be determined from the new soil level resulting from the filling or cutting mentioned above, and soil in immediate contact with the vertical surfaces of RCC foundations shall be treated at the rate of 7.5 litres per square metre. The other details of treatment shall be as laid down in "Treatment for Masonry Foundation & Basements (b)".

(C) Treatment of Top Surface of Plinth Filling

The top surface of the filled earth within the plinth walls shall be treated with chemical emulsion at the rate of 5 litres per sqm of the surface before the sand / sub-grade is laid. Holes upto 50 to 75 mm deep at 150 mm centres both ways shall be made with crow bars on the surface to facilitate saturation of the soil with chemical emulsion.

(D) Treatment at Junction of the Walls and the Floor

To achieve continuity of the vertical chemical barrier on inner wall surfaces from the ground level, a small channel 30 x 30 mm shall be made at all the junctions of walls and columns with the floor (before laying the sub-grade) and rod holes made in the channel upto ground level 150mm apart and the chemical emulsion poured along the channel @ 7.5 litres per sqm of the vertical wall or column surface so as to soak the soil right to bottom. The soil shall be tamped back into place after this operation.

(E) Treatment of Soil along External Perimeter of Building

After the building is complete, 300 mm deep holes shall be provided in the soil with iron rods along the external perimeter of the building at intervals of about 150 mm and these holes shall be filled with chemical emulsion at the rate of 7.5 litres per sqm of vertical surfaces of external walls. If the depth of filling is more than 300 mm, the external perimeter treatment shall extend to the full depth of filling upto the ground level so as to ensure continuity of the chemical

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barrier. In case the earth outside the building is graded on completion of building, this treatment shall be carried out on completion of such grading.

(F) Treatment of Soil under Apron (Plinth Protection) along External Perimeter of Building

Top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion at the rate of 5 litres per square metre of the surface before the apron is laid. If consolidated earth does not allow emulsion to seep through, holes upto 50 to 75 mm deep at 150 mm centres both ways may be made with 12 mm diameter mild steel rod on the surface to facilitate saturation of the soil with the chemical emulsion.

(G) Treatment for Expansion Joints

Anti-termite treatment shall be supplemented by treating with chemical emulsion through the expansion joint after the sub-grade has been laid @ 2 litres per linear metre of expansion joint. Treatment of Wall Retaining Soil above Floor Level

Retaining walls like the basement walls or outer walls above the floor level retaining soil need to be protected by providing chemical barrier by treatment of retained soil in the immediate vicinity of the walls, so as to prevent entry of termites through the voids in masonry, cracks and crevices etc. above the floor level. The soil retained by the walls shall be treated at the rate of 7.5 litres per square metre of the vertical surface so as to affect a continuous outer chemical barrier, in continuation of the one formed under "Treatment for Masonry Foundation & Basements."

(H) Treatment of Soil Surrounding Pipes, Waste and Conduits

When pipes, waste and conduits enter the soil inside the area of the foundations, the soil surrounding the points of entry shall be loosened around each such pipe water or conduit for a distance of 150 mm and to a depth of 75mm before treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated for a distance of over 300 mm unless they stand clear of the walls of the buildings by about 75 mm.

5.02.00 SUPER STRUCTURE

5.02.01 STRUCTURAL FRAME

5.02.01.01 The super structure shall be made of structural steel made of Hot rolled steel sections complying to IS: 2062 with minimum yield strength of 250 MPa or as per material specification at Cl.no. 5.21.00 of the specification.

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The structure shall be designed to withstand all loads and load combinations as per Indian Standards (latest revisions) such as IS:875, IS:1893, IS:800, IS:456 etc.

- 5.02.01.02** The structural elements shall include all columns, beams, bracings, floor joists, runners, brackets, roof truss, purlins, stringers, treads, landings etc. of stair cases, including use of chequered plate if required, all complete etc in single section with or without connecting plate/built up section, trusses, framed work/ built up tubular (round, square or rectangular hollow tubes etc.) works etc., including cutting, hoisting, fixing in position, welding and bolted with special shaped washers etc. complete, providing and fixing mild steel round holding down bolts with nuts and washer plates complete and applying a priming coat of approved steel primer. The items shall be executed as per relevant DSR items, CPWD specifications (latest) and drawings issued by owner.
- 5.02.01.03** All surfaces of structural steel which are to be necessarily painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. Surfaces not in contact but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. Part to be encased in concrete shall not be painted or oiled. A priming coat of approved steel primer such as Red Oxide/Zinc Chromate primer conforming to IS 2074 shall be applied before any member of steel structure are placed in position or taken out of workshop. All exposed Steel surfaces shall be painted with two coats of synthetic enamel paint of approved make over primer (one shop and one on site after erection) as per DSR item no. 13.62 and work to be executed as per relevant CPWD specifications therein.
- 5.02.01.03** All RCC work like pedestal supporting structural columns/encasement of columns shall be upto plinth level.
- 5.02.01.04** All steel structures shall be fabricated in factory, transported and erected at site. All factory fabricated structures shall have bolted field connections. All fabrication shall be done in factory approved by Engineer in accordance with IS:800: 2007 read in conjunction with relevant codes mentioned therein.

Shop Connections

Shop connection may be welded connection. Welding shall be in accordance with IS. 816-1969, IS 819-1957, IS 1024-1979, IS1261-1959, IS 1323-1982 and IS 9595-1980 as appropriate. For welding of any particular type of joint, welders shall give evidence of having satisfactory completed

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appropriate test as described in IS 817-1966 or IS 1393-1961 or IS 7307 (part-I) –1974 or IS 7310 (part-I) 1974 or IS 7318 (part-I) 1974 as relevant.

Site Connections

All bolted connections shall be provided with bolts, nuts, washers conforming to IS 1367.

5.02.02 Supporting Slab for flooring:

Flat roof/floors (deck slab) shall be provided at locations as per tender drawings and shall be designed for all loads and load combinations of IS: 875.

The deck slab shall be of composite structure where the troughed colour coated metal deck sheets shall be used as permanent shuttering and shall have adequate strength to support weight of green concrete and imposed loads during construction as per manufacturer's recommendations/ calculations/ test certificates. These profiled metal deck sheets shall be fixed to the structural steel members as beams/ joists using headed shear anchor studs.

5.02.02.01 Metal Deck

(A) Material :

Metal profiled sheets shall have minimum 0.8mm bare metal thickness (i.e. excluding the thickness of galvanizing and coating) galvanised to grade 275 as per IS 277, of minimum yield strength of 250 MPa of drawing grade as per IS 513.

These profiled deck sheets shall be fixed to the top flange of beams by means of drawn arc welding of headed shear anchor studs directly through the metal sheet. The shear anchor studs shall be provided at regular interval on all top flange / flange plate of structural beams and shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 19mm diameter and 100mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.

The deck sheet shall be fixed to the frame structure with the help of washers and bolts or self drilling self tapping screws with EPDM seal. The

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spacing shall be as per the design done by the bidder for the fasteners considering the wind load, self load and other associated loads.

(B) Colour Coating:

Sheet shall be of approved colour and shade. Sheets shall be colour coated with total coating thickness of at least 40 microns (nominal) comprising of silicon modified polyester (SMP) paint or Super Polyester paint or SDP paint (Super Durable Polyester with no TGIC Triglycidyl Isocyanurate). The silicon content in the SMP paint to be 30% to 50%. The paint to be, of minimum 20microns (nominal) dry film thickness (DFT) on external face over primer coat of minimum 5 microns (nominal) and minimum 10 microns (nominal) SMP or super polyester paint over primer coat of minimum 5 microns (nominal) on internal face. SMP and Super polyester paint/SDP systems shall be of industrial finish of product type 4 of AS/NZ2728.

Also, the heavy metal content (Lead, Cadmium, Chromium etc) to be within environmental norms.

(C) Design Criteria :

The sectional modulus and moment of inertia of troughed profile per meter width shall be so as to limit the deflection of sheets to span/250 under total super imposed loading (DL+LL) comprising the self-weight of metal deck sheet, dead weight of green concrete and an additional construction load 100kg per sqm for two span condition. The section modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS 801 for satisfying the deflection and strength requirements.

The spacing of structural steel secondary beams shall be based on the bending capacity of the metal deck sheet for self-weight of green concrete and additional construction load of 100 kg/m².

(D) Miscellaneous Details

(i) The sheeting shall be fixed as per the working drawings. Sheets shall be supplied in required sizes (based on support 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

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shall be done on the sheet. If any sheet is found with gas cut mark, same shall stand rejected and shall be immediately replaced.

(ii) Distorted, blemished or water stained sheets shall not be used.

(iii) Before installing sheet, it shall be ensured that the support beams are in true planes, correctly placed and securely fixed.

(iv) 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.

(v) Length of the sheet shall be such as to cover minimum 3 span spacings.

(vi) The decking sheets shall be fixed to the beams with the help of self drilling and tapping type fasteners and neoprene washers.

(vii) Lap between the sheets shall be at least 150mm in the longitudinal direction and at least one crest wide in the transverse direction which shall be properly anchored / fixed with fasteners.

(viii) 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.

The bidder shall prepare working drawings of sheeting system including end and side laps, flashing, fixing details etc. before starting sheeting work at site.

5.02.02.02 RCC works

The RCC slab shall be minimum 115mm thick with M25 design mix and 20mm nominal size aggregate above the top surface (crest) of the installed metal deck sheet and adding admixture of required proportion to accelerate/retard setting of concrete, improve workability, without impairing strength and durability. The work shall be as per DSR item no. 5.33 and relevant CPWD specifications.

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Proper curing and watering shall be done for the strength of concrete as per IS specifications. Flat roofs/floors deck slab concrete shall be mixed with water proofing compound of approved make in proportion as per manufacturer's specifications.

5.02.02.03 Other Details

The finished floor of all the toilets shall be 20mm lower than the finished floor level.

Provision of openings of required size is to be made in the deck slab for passing of the sanitary & plumbing pipes as per drawings and as directed by engineer in charge.

5.02.03 Structure for Staircase:

The Staircase shall be made from MS Supporting Structure with risers, treads, landings, handrails with floor finishes as specified elsewhere in this specification.

5.02.03 Supporting structure for Over Head Water Tank (OHT)

5.02.03.01 Separate steel staging shall be provided for supporting overhead water tanks (OHTs) of required capacity for Pre-engineered Accommodations as per details of OHTs mentioned elsewhere in this specification and as per issued tender drawings for minimum staging height of 9m. The structure shall be of MS including columns, beams, bracings, joists, runners, stringers, treads, landings, railings etc. including use of chequered plate if required, all complete.

Each supporting platform shall be 55sqm (min) in plan. The platform supporting OHT shall be provided with toe guard and railing on all sides upto 1.2m height from the supporting platform. Proper access system, i.e, ladder/staircase with hand railing from GL upto platform supporting OHT shall be provided. Sufficient clear way for movement shall be provided along all sides of the platform. The platform shall also accommodate fire water storage tank, terrace pumps, associated piping and instruments for fire fighting system of the building. Sufficient space for operation and maintenance of the system shall be provided.

The structure shall be designed to withstand all loads and load combinations as per Indian Standards (latest revisions) such as IS:875, IS:1893, IS:800, IS:456 etc.

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All foundation arrangement system like RCC footings, columns, pedestals, tie beams, brickworks etc shall be provided. All works like necessary excavation, PCC, backfilling, compaction, etc upto FGL to support the superstructure conforming to relevant Indian standards on the basis of soil investigation shall be done.

5.02.03.02 Foundation System

- (a.) All structures shall be supported on suitable open foundations (isolated, combined, raft).
- (b.) No foundation shall rest on the filled up ground / soil.
- (c.) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards. The water table for design purpose shall be considered at Finished Ground Level (FGL).
- (d.) The minimum width of foundation shall be 1.0m and min. depth of foundation shall be 1.5m below natural ground level.

The steel structure shall be made of Hot rolled sections complying to IS: 2062 with minimum yield strength of 250 MPa or as per material specification at Cl.no. 5.21.00 of the specification. For RCC substructure, min. grade of concrete to be used shall be M25 and reinforcement steel shall comply to High strength deformed TMT steel bars of grade Fe-415/Fe500/Fe 500D/Fe550D and shall conform to IS 1786.

5.03.00 Wall cladding

5.03.01 PUF Insulated Wall Panels

1. Wall/Partition panel shall be PUF insulated composite Panel of 50mm thick PU insulation having 40±2 Kg Density sandwiched between 0.5mm PPGL sheets on both sides
2. All materials required shall be new and shall comply with relevant Bureau of Indian Standard specification and bear the mark.

5.03.02 PU Foam Insulated Core

1. The PU insulated core shall be CFC free and Zero Ozone depleting
2. panel using N Pantane blowing agent.
3. The PU Foam shall be self-extinguishing as per ASTM D 1692, fire retardant type (as per Pt.5 & class-I as per point 7 of BS:476)
4. The PU Foam shall have bulk density of 40±2 kg/cum and shall conform to PUR 1 Grade of IS:12436/1988 (reaffirmed 2011)

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5. These panels are to be manufactured from continuous line automatic machine to ensure that the insulation core of the panel is formed in one piece and provides desired structural and physical properties.

5.03.03 GI Metal Skin- PUF Panels

1. The pre coated galvanised steel sheet shall be of minimum 240 MPa steel grade confirming to IS 14246:1995
2. Pre-coated GI Sheet shall be 0.5mm BMT (i.e. excluding the thickness of galvanizing and coating) hot dipped galvanized with minimum 220 GSM of zinc coating on both sides per IS: 277:2003
3. Sheet shall be of approved colour and shade. Sheets shall be colour coated with total coating thickness of at least 40 microns (nominal) comprising of silicon modified polyester (SMP) paint or Super Polyester paint or SDP paint (Super Durable Polyester with no TGIC Triglycidyl Isocyanurate). The silicon content in the SMP paint to be 30% to 50%. The paint to be, of minimum 20microns (nominal) dry film thickness (DFT) on external face over primer coat of minimum 5 microns (nominal) and minimum 10 microns (nominal) SMP or super polyester paint over primer coat of minimum 5 microns (nominal) on internal face. SMP and Super polyester paint/SDP systems shall be of industrial finish of product type 4 of AS/NZ2728
4. The top finished surface of PPGI sheet shall also have guard film/protection sheet (polyethylene) of min. 25 micron for protection against scratches during handling and transportation

5.03.04 Fasteners & Fittings

1. The wall panels at the corners shall be joined by PPGI corner angles / flashings. As all flashings are of PPGI, no welding shall be allowed. The PPGI angle and flashings shall be bended riveted to form desired shape and size.
2. The panels shall be provided with tongue and groove interlocking arrangement made out from continuous line automatic machine & silicone sealant shall be applied on tongue & Groove joints.
3. The panels shall be supplied with all types of necessary flashings like Bottom Channel (U Channel), Internal and External Perimeter building, C Flashings for cut out areas, Anchor Fastener, screws, Rivets and silicone sealant.
4. Gable End: Gable end shall be covered with same panels as of wall. These panels to be fixed on arrangement on the end trusses.
5. The colour of panels shall be as per direction of Engineer-in-charge.

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6. The gap between bottom steel track and plinth beam is to be filled with 6mm thick neoprene rubber having adequate width as per design to provide damping and resist any sort of water leakage.

5.04.00 ROOFING

5.04.01 PUF Insulated Roof Panels

1. Roof panel shall be PUF insulated composite corrugated Panel of 40/70 mm thick PU insulation having 40 ± 2 Kg Density sandwiched between 0.5mm PPGL sheets on both sides. The panels shall comprise top sheet as troughed permanently colour coated sheet & bottom sheet as plain permanently colour coated.
2. All materials required shall be new and shall comply with relevant Bureau of Indian Standard specification and bear the mark.

5.04.02 PU Foam Insulated Core

1. The PU insulated core shall be CFC free and Zero Ozone depleting panel using N Pantane blowing agent.
2. The PU Foam shall be self-extinguishing as per ASTM D 1692, fire retardant type (as per Pt.5 & class-I as per point 7 of BS:476)
3. The PU Foam shall have bulk density of 40 ± 2 kg/cum and shall conform to PUR 1 Grade of IS:12436/1988 (reaffirmed 2011).
4. These panels are to be manufactured from continuous line automatic machine to ensure that the insulation core of the panel if formed in one piece and provides desired structural and physical properties.

5.04.03 GI Metal Skin- PUF Panels

1. The pre coated galvanised steel sheet shall be of minimum 240 MPa steel grade confirming to IS 14246:1995.
2. Pre-coated GI Sheet shall be 0.5mm BMT (i.e. excluding the thickness of galvanizing and coating) hot dipped galvanized with minimum 220 GSM of zinc coating on both sides per IS: 277:2003
3. Sheets shall be of approved colour and shade. Sheets shall be colour coated with total coating thickness of at least 40 microns (nominal) comprising of silicon modified polyester (SMP) paint or Super Polyester paint or SDP paint (Super Durable Polyester with no TGIC Triglycidyl Isocyanurate). The silicon content in the SMP paint to be 30% to 50%. The paint to be, of minimum 20microns (nominal) dry film thickness (DFT) on external face over primer coat

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of minimum 5 microns (nominal) and minimum 10 microns (nominal) SMP or super polyester paint over primer coat of minimum 5 microns (nominal) on internal face. SMP and Super polyester paint/SDP systems shall be of industrial finish of product type 4 of AS/NZ2728

4. The top finished surface of PPGI sheet shall also have guard film/protection sheet (polyethylene) of min. 25 micron for protection against scratches during handling and transportation

5.04.04 Fasteners & Fittings

1. The roof panel shall be installed with downward slope overlapping methodology
2. The roof panels shall be laid over existing frame work of trusses, and purlins provided with all necessary flashings like top and bottom ridge cover, gable end flashings, gutter and down take pipes, SDST Screws, butyl tape and foam filler. Self Drilling & Self Tapping (SDST) screws are fixed on each ridge of PPGI sheet in all purlins of the Roof. All overlaps between sheets shall also be tightened using SDST screws. Butyl Tape shall be applied on the roof joints during installation to avoid water leakage.
3. Ridge Cover: Roof projection along all sides of building shall be as per tender drawings. The outer projection shall be of same material & colour as that of outside colour of roof panel and the inner shall be of same material & colour that of inside colour of roof panel.
4. Foam Filler-50 mm wide foam filler of appropriate shape shall be placed / fixed in all the gaps between the corrugated PPGI roof sheets and the Ridge cover to prevent reverse flow/leak of snow/rainwater/Air. Each foam filler shall be secured to the roof sheets through double-sided adherence Industrial tape.

5.04.05 Roof Projection and roof water drainage:

1. The roof shall have minimum projection from the eaves wall and from gable end as per tender drawings. Purlins shall also be provided on the roof at the eaves and at gable roof extension (outside the structure). At the end of projected roof, PUF panel shall be sealed with flashing and silicone sealant along with projected PPGI 0.5mm sheet as per tender drawings.
2. Rain water down comers shall be provided from roof gutter upto peripheral surface drain. 0.5mm thickness PPGI folded sheeting with PVC down comer pipe shall be provided along with necessary fasteners and supports.
3. The bidder shall prepare all working drawings including end and side laps, fixing details etc. before starting work at site.

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5.05.00 Staircase Treads

The Staircase shall be made from MS Supporting Structure with risers, treads and landings with floor finish of 18mm thick mirror polished marble. The marble slabs shall be fixed to MS support structure having MS plates with the help of approved fixing material. Handrails shall be of approved design fabricated with Square bars, flats and hollow tubular section. Top of handrail shall be 50mm dia MS pipe with two coats of synthetic enamel paint of approved make over suitable primer.. Each tread of staircase shall have 2 No. of grooves (6mm x 6mm) along the length. The bidder shall submit shop drawings showing all fixing details, color, finishes etc. for approval of engineer in charge before execution.

5.06.00 Railings/Handrails:

Stainless steel handrails of approved design fabricated with Square bars, flats and hollow tubular section shall be provided wherever required .

5.07.00 Covering to Internal steel Columns:

All the internal steel structural columns to be covered up to false ceiling height with 8mm thick cement fibre board with necessary fixing arrangements. Two coats of acrylic emulsion paint (conforming to CPWD DSR Item No. 13.60) of matching colour shall be provided over primer and white cement based putty (1mm thick) as per DSR Item no.13.80. The bidder shall submit shop drawings showing all fixing details, color, finishes etc. for approval of engineer in charge before execution.

5.08.00 Flooring / Dado / Skirting:

5.08.01 Ceramic Tiles:

5.08.01.01 Dado - Ist quality ceramic glazed wall tiles (300x600mm in DIGITAL series of Kajaria/Nitco/ Somany/ RAK/ Johnson) conforming to IS:15622 (thickness to be specified by the manufacturer) in all colours & shades as approved by Engineer-in-Charge, fixed with cement based high polymer modified quick set tile adhesive (water based) confirming to IS: 15477, in average 6 mm thickness, including grouting of joints. Adhesive for fixing tiles conform to CPWD Specifications Clause No. 11.17.2. Tiles to be fixed over 10mm thick cement fibre board fixed to 50mm PUF wall .

Note: All fibre cement board shall be as per IS: 14862, Type –B, Category 3 for interior areas and as per IS: 14862, Type –A, Category 3 or 4 for exterior exposed surfaces.

5.08.01.02 Flooring - Ceramic glazed floor tiles of size 300x300 mm / 600mmx600mm (in DIGITAL series of Kajaria/ Nitco/ Somany/ RAK/ Johnson / Approved

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make, thickness to be specified by the manufacturer) of 1st quality conforming to IS: 15622 of approved make in all colours and, laid on 20 mm thick cement mortar 1:4 (1 Cement: 4 Coarse sand), including mixing water proofing material in work in proportion recommended by the manufacturers, pointing the joints with white cement and matching pigment etc. complete.

5.08.02 **Vitrified Tiles:**

Glazed vitrified(600X600MM) / 600mmx1200mm tiles matt/antiskid finish (DSR 11.41A.3) & Double charge vitrified tiles(600X600MM) polished finish (DSR-11.41A.1 (Kajaria/ RAK/ Nitco / Somany/ Johnson),thickness to be specified by the manufacturer) with water absorption less than 0.08% and conforming to IS:15622 of approved make in all colours and shades, laid on 20 mm thick cement mortar 1:4 (1 cement : 4 coarse sand) for flooring and over 12 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand) in skirting, riser of steps, including grouting the joints with white cement and matching pigments etc. complete.

18 mm Thick pre-polished Udaipur Green and Agaria White Marble:

For quality and execution of Marble flooring, CPWD Specifications 2019, Clause No. 8 shall be followed.

Notes for Flooring / Dado / Skirting:

1. Treads of all steps shall be bull nosed and provided with 2 No. of grooves (6mmx6mm) along the length.
2. 100mm high Skirting finish shall match floor finish except where dado is provided.
3. Toilets and hand wash: Wall dado up to false ceiling height shall be provided.
4. Kitchen and Pantry: Wall dado up to 600mm height above service platform shall be provided with Ceramic wall tile.

5.09.00 **Gypsum Board Tile Ceiling:**

All rooms and corridors shall be provided 12.5 mm thick square edge PVC Laminated Gypsum Tile of size 595x595 mm, conforming to CPWD DSR 20123, Item No. 12.52.3 shall be provided.

5.10.00 **GI Metal Tile Ceiling:**

Portico, Toilet & kitchen shall be provided with interlocking type GI metal false ceiling. The false ceiling shall be adequately secured & supported on structural steel framework so as to resist the uplift due to design wind forces.

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The portion between the false ceiling and roof panel shall be covered on all the sides to avoid entry of rain water and wind.

GI Metal Tile conforming to CPWD DSR 2023, Item No. 12.52.2 shall be provided.

5.11.00 Platforms:

Platforms in wash, kitchen, pantry, toilet etc. with: Supporting Structure: Shall be made from MS Supporting Structure. Platform Top: top shall be of 18mm thick Granite (Cat's Eye Brown/ Black Granite), gang saw cut, mirror polished, pre-moulded and pre polished, machine cut of required size pasted with adhesive over 12mm Heavy Duty Cement Board (conforming to IS 14862: 2000, Type –A, Category –IV, compressed after forming and before autoclaving) as Substrate including cutting openings for sinks, resting on supporting structure. The gap between vertical wall surface and platform shall be sealed with silicone sealant. If required, secondary support from main structure may be taken to support the sink / wash basin etc. All the dimensions shall be as per tender drawings. All the joints shall be sealed with sealant and tape to provide smooth and crack free surface. All exposed steel surfaces shall be painted with synthetic enamel paint of approved shade. This work includes all screws, brackets, fasteners, tape, sealants, nut, bolts, washers etc. complete. The bidder shall submit shop drawings showing all fixing details, color, finishes etc. for approval of engineer in charge before execution.

5.12.00 Doors:

5.12.01 Frames: Pressed Steel Frames conforming to CPWD DSR 2023, Item No. 10.14 shall be provided. Grouting inside of pressed steel frames of profile shall be done with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 12.5mm nominal size) including shuttering etc. complete.

5.12.02 Flush Shutters: 35mm thick Non –decorative flush shutter including ISI marked Stainless

Steel butt hinges with necessary screws conforming to CPWD DSR 2023, Item No. 9.21.1 shall be provided in all rooms. Toilets shall be provided with 30 mm thick including ISI marked Stainless Steel butt hinges with necessary screws conforming to CPWD DSR 2023, Item No. 9.21.2

5.12.03 Wire-gauge Shutters: 35 mm thick wire gauge shutters using stainless steel grade 303 wire gauge with wire of dia 0.5 mm conforming to CPWD DSR 2021, Item No. 9.134.1.2.2 shall be provided. The shutters shall be painted with two coats of synthetic enamel paint of approved shade over suitable primer.

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- 5.12.04 Lamination:** 1 mm Thick decorative high pressure laminated sheet of plain / wood grain in gloss / matt/ suede finish conforming to CPWD DSR 2023, Item No. 9.125
- 5.12.05 PVC Rigid Foam Sheet:**
- All toilet doors shall be provided with PVC rigid foam sheet 1 mm thick conforming to CPWD DSR 2023, Item No. 9.125 on inner side and 1 mm Thick decorative high pressure laminated sheet on outer side.
- 5.12.06 Aluminium Doors:**
- Powder coated aluminium doors shall be with extruded built up standard tubular sections, appropriate Z sections and other sections of approved make conforming to IS:733 and IS:1285, fixed to Pre-engineered structure including fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/ neoprene gasket etc. including hinges / pivots and double action hydraulic floor spring of approved brand and manufacture IS:6315 marked, lock, SS handle (minimum 300mm length and with approximately 25mm dia. 1.5mm thick Stainless steel Grade 303 hollow pipe) and all necessary fittings all complete as per the directions of Engineer-in-Charge. Glazing shall be clear float glass of minimum 5.0 mm thick.
- Lamination: 1 mm Thick decorative high pressure laminated sheet of plain / wood grain in gloss / matt/ suede finish conforming to CPWD DSR 2023, Item No. 9.125 .
- 5.12.07 Door Fittings:** Aluminium fittings such as Tower bolts, handles, sliding bolt, door stopper etc. ISI marked anodised (anodic coating not less than grade AC 10 as per IS: 1868) shall be provided with sizes as given in tender drawings shall be provided.
- 5.13.00 Windows:** Powder coated aluminium opening / sliding (2/3 Track) Window with 18mm shutters (Deluxe section), including one shutter with SS Mesh - Outer Frame with top, bottom and side track section of minimum 92mmx31.75x1.30mm. with dash fasteners of required number, dia. and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/ neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / panelling, C.P. brass / stainless steel screws, with all necessary Aluminium section fixtures and fastenings such as roller bearing in nylon casting, automatic flush type lock etc., all complete as per approved shop drawings, based on adequacy in wind pressure 120Kg/m², and the directions of Engineer-in-charge. 18mm shutters, with top and bearing bottom sections of

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minimum 40x18x1.09mm, Interlocking section minimum 40x18x1.00mm and Handle section minimum 40x18x1.09mm shall be used. Stainless steel (Grade 303) wire Gauze of 0.5 mm dia. wire & 1.4 mm Aperture in both directions in Aluminium window as directed by Engineer-In-Charge. Glazing in windows shall be float 5mm (min.) thick glass panes.

The bidder shall submit shop drawings of doors & windows showing all fixing details, colour, finishes etc. for approval of engineer in charge before execution.

5.14.00 Internal Paint:

For all dry areas two coats of acrylic emulsion paint (conforming to CPWD DSR Item No. 13.60) shall be provided over primer and white cement based putty (1mm thick) as per DSR Item no.13.80. All exposed Steel surfaces shall be painted with two coats of synthetic enamel paint of approved make over suitable primer.

5.15.00 Plumbing System:

Sanitary and CP Brass Fittings: All fittings in kitchen and toilet shall be approved by EIC.

All sanitary installation shall be fitted with best quality CP brass fittings of reputed make and as per relevant Indian standards, with all bends, tees, junctions, sockets, fasteners etc. as necessary, supply and drainage connection for efficient working of plumbing system, complete.

5.16.00 Plinth Protection and Surface Drain

- a) 750mm wide plinth protection with 50mm thick of cement concrete 1:3:6 (1 cement : 3 coarse sand (zone-III) derived from natural sources : 6 graded stone aggregate 20 mm nominal size) over 75 mm bed of dry brick ballast 40 mm nominal size well rammed and consolidated and grouted with fine sand including finishing the top smooth, shall be provided around the Pre-Engineered Structure. (to be executed as per DSR item no 4.17 and corresponding CPWD specifications)
- b) 200mm wide x 200mm average depth brick masonry open surface drain duly plastered with 12mm plaster (1:4) with a floating coat of neat cement shall be provided along plinth protection with final outlet towards the road side drain. The open drains as specified in the item shall be laid to such gradients and in such locations as may be shown in the relevant drawing or as directed by the Engineer-in-Charge. The size of the drain as specified shall be the width of the drain at the top, measured between the masonry walls. The drain shall be given, as far as possible, uniform slope from the starting point to the discharge point.

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5.17.00 External Area Development

- a) Minimum 10m wide area with parking facility shall be cleaned and levelled neatly. The area shall be raised upto F.G.L. by filling with soil. The required soil for filling may be done either with excavated earth or good earth/moorum/sand arranged by the bidder or as directed by the engineer-in-charge.
- b) Connection by Approach Road/ Pathways shall be provided to proposed structures from nearest road. Layout of approach road shall be as per tender drawings/as per instructions of EIC required at site.

5.18.00 Approach Road (Cement Concrete):

Approach road shall be minimum 3.75m wide and 1.5m wide berm on both sides of the road. Concrete road and berm shall be 100mm thick over a well compacted and consolidated 150mm thick moorum after excavating earth to an average of 20cm depth, dressing to camber and consolidating including making good the undulations etc and disposal of surplus earth lead.

Camber for road at 1:40 shall be ensured.

5.19.00 Pathway:

Courtyard pathways, berms on both sides of roads, parking and pathway in general shall be provided with 60 mm thick CC interlocking paver block of M-30 grade laid in required colour and pattern over and including 50 mm thick compacted bed of coarse sand ,filling the joints with fine sand etc. Below sand 100 mm thick PCC 1:4:8 (1 cement: 4 Coarse sand: 8 40 mm thick stone aggregate) shall be provided.

200 mm thick Concrete Kerb Stone (300x300) on edge shall be provided on both side of pathway and on edge of berms of road.

5.20.00 PLUMBING SYSTEM:

5.20.01 Sanitary and CP Brass Fittings:

All fittings in the kitchen and toilet shall be provided as specified elsewhere in this specification. All sanitary installation shall be fitted with best quality CP brass fittings of reputed make and as per relevant Indian standards, with all bends, tees, junctions, sockets, fasteners etc. as necessary, supply and drainage connection for efficient working of plumbing system, complete.

5.20.02 Water Storage Tanks

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Providing and placing on roof/separate staging (as marked in tender drawing) Polyethylene Water Storage Tanks ISI 12701 marked with all works inclusive, in line with DSR 2021 Item no. - 18.48 (including fire storage tank).

All works required for supporting and fixing the water tank on roof/ separate stage is in the scope of bidder and shall be executed as per approved design and drawing.

5.20.03

Water supply piping –

CPVC pipes (as per IS 15778) of required size and number shall be provided from finished ground level at main water supply point in building periphery to Water storage tank and for all internal connections (sanitary fixtures as shown in the tender drawing) from water tank. All valves, joints, Tees or other items required to complete the piping works shall be in the scope of bidder.

Tapping from nearest water supply point to the Overhead water tank is in the scope of the bidder.

5.20.04

Internal & External Sewerage system –

Sewerage system shall be designed for the facilities shown in tender drawings. ISI marked UV stabilized UPVC pipes shall be used for soil, waste and vent pipe, Type-B as per IS: 13592. All joints, Bends and other items required to complete the Sewerage system works shall be in the scope of bidder.

Design, engineering, supply, installation and testing of all the water supply piping and internal sewerage system upto nearest manhole is in the scope of bidder.

Bidder shall get the drawings approved before starting the execution of work.

5.21.00

Materials

The following table give the details of minimum criterion for selecting construction materials in design of all facilities wherever not mentioned in specifications otherwise:

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Type of Material	Minimum Strength/Class	Exceptions if any
Cement	Fly ash based portland pozzolana cement conforming to IS: 1489 (Part-1)	Excluding works with white cement
Reinforcement steel	High strength deformed TMT steel bars of grade Fe-415/Fe500/Fe 500D/Fe550D and shall conform to IS 1786	
Structural Steel	<p>a) Rolled sections shall be of grade designation E250, Quality A/BR, Semi-killed/ killed conforming to IS 2062. All steel plates shall be of Grade designation E250, Quality BR (fully killed), conforming to IS 2062 and shall be tested for impact resistance at room temperature.</p> <p>Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.</p> <p>b) Pipes shall conform to IS: 1161.</p> <p>c) Hollow (square and rectangular) steel sections shall be hot formed conforming to IS: 4923 and shall be of minimum Grade Y240 and minimum thickness shall be 4 mm.</p> <p>d) Chequered plate shall conform to IS 3502 and shall be minimum 6 mm thick excluding projection. Steel for chequered plate shall conform to grade E250A semi killed of IS:2062 or equivalent grade conforming to ASTM & BS standards only.</p>	

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Bricks	Bricks shall be non modular Fly ash lime bricks conforming to IS: 12894 and shall have minimum compressive strength of 75kg/cm ²	
P.C.C. below all substructure, foundations, trenches, etc.	100 mm thick 1:4:8 as per DSR item no 4.1.8	
Concrete for all substructure and superstructure works (Except Road works)	Grade M25 as per IS 456 and DSR item no 5.33	
Concrete pavements	DSR Item No. 16.42	

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INTERNAL ELECTRIFICATION WORKS

6.00.00 Intent of Specification

- a) This specification is intended to cover Internal Electrification for the GNI project pre-engineered accommodation , 16 single room , 6 suite room accommodation , dining , kitchen store utility. It is not the intent to specify completely herein all aspects of design and constructional features of equipment and details of the work to be carried out, nevertheless, the equipment and work shall conform in all respects to high, standards of Engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the owner who will interpret the meaning of the specifications and drawings and shall have right to reject or accept any equipment or work which in this assignment is not complete to meet the requirements of this specification and/or applicable Codes and standards mentioned elsewhere in the specifications.
- b) **The electrical equipment/items shall be supplied & installed as per CPWD Specifications (Part-1 Internal) 2023 with up to date corrections/amendments and as per relevant technical specifications mentioned in this document.**

6.01.00 Scope of Work

The scope of work under this specification shall include Design, Fabrication, Supply, Storage, Erection, Testing and Commissioning of following items for complete internal electrification of GNI project pre-engineered accommodation , 16 single room , 6 suite room accommodation , dining , kitchen store utility:

- (a) Main Distribution Boards & Meter Boards with energy meter
- (b) Lighting Panels
- (c) Lighting/Power Distribution System for the building complete with wires, steel conduits, switch/socket outlet boxes, switches, sockets, receptacles and accessories etc.
- (d) LED Lighting fixtures including all accessories
- (e) All types of fans including all accessories/connections
- (f) LT Power Cables/wires with necessary terminations and other accessories, if required from MDB/MB to Lighting panels
- (g) Earthing & Lightning Protection System
- (h) Telephone & T.V. outlets complete with Boxes, steel conduits, cables / wires, accessoires etc.

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- (i) Hume pipes for all types of cables & any other work required not mentioned above, however, necessitated for completion of internal electrification.
- (j) Water Geysers(5 star rated) with all accessories/connections.
- 6.01.01 The scope of work shall also include all civil works associated with erection of Meter Boards, Distribution boards, Lighting panels and laying/erection of conduit either concealed in walls or ceiling, switch boxes, receptacles, earthing & lightning protection system etc. Minor Civil Works like fixing of anchor bolts clamps, cleats and breaking of walls/ floor for installing conduits/cables/earthing conductors etc. and sealing of walls / floors afterwards shall also be included in the bidder's scope.
- 6.01.02 Materials and components not specifically stated in these specifications but are necessary for operation of the systems, mentioned therein shall be deemed to have been included in the scope of work of these specifications. Whether called for specifically or not, all accessories, hardware and services required for normal satisfactory testing, commissioning, operation of equipment/system shall be deemed to be included in the bidder's scope and cost of these shall be included in unit rates quoted by the Bidder.
- 6.01.03 The Electrical Bidder shall also obtain at his cost all the sanctions from relevant authorities such as installation checked and approved by the Electrical Inspector or from any other authority if required, on behalf of the owner.
- 6.01.04 The tender drawings show the lighting layout of the building in general. However, the detailed circuit diagrams, conduit layouts etc. for construction shall be prepared based on construction architectural layouts by the bidder and submitted for owner's (site Engineer-in-charge) approval during detailed engineering. It shall be the responsibility of the bidder to estimate the quantities of conduits, wires and other equipment/materials etc. correctly as per approved layouts/drawings.
- 6.01.05 The bidder shall furnish all relevant drawing, data sheets, catalogues, instructions manuals of the equipment supplied by him as per the requirements of the contract.

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6.01.06 The bidder shall submit to owner one marked up copy and one original copy of all as built drawings after installation of the lighting fixtures and other equipment covered under this package for effecting any changes in the originals. This work shall be done immediately after completion of erection work in a particular area. Price quoted by the bidder shall be inclusive of furnishing of the above drawings.

6.02.00 Internal Wiring:

6.02.01 Point wiring in Steel conduit, with modular type switches for light point/fan point/exhaust fan point/call bell point/socket point with 1.5 sq. mm FRLS PVC insulated copper conductor single core cable in surface/ recessed Steel conduit, with modular switch, modular plate, suitable Flame retardant & heat resistant modular box and earthing the point with 1.5 sq. mm. FRLS PVC insulated copper conductor single core cable etc. as required shall be used.

6.02.02 Light plug point wiring in Steel conduit, with modular type switch and socket 1.5/2.5 sq.mm FRLS PVC insulated copper conductor single core cable in surface/ recessed Steel conduit, along with 1.5/2.5 sq.mm FRLS PVC insulated copper conductor single core cable for loop earthing including providing and fixing 3 pin 5/6 amps modular socket outlet and 5/6 amps modular switch, connection, painting etc. as required shall be used.

6.02.03 Wiring for power plug with 2x4 sq.mm or suitable capacity of FRLS PVC insulated copper conductor single core cable in surface/ recessed Steel conduit along with 1 No 4 Sq.mm FRLS PVC insulated copper conductor single core cable for loop earthing including providing and fixing 6 pin 15/16 & 5/6 amps modular socket outlet and 15/16 amps modular switch, connection, painting etc. as required.

6.02.04 Wiring for circuit/ sub-main wiring along with earth wire of FRLS PVC insulated copper conductor of suitable capacity, single core cable in surface/ recessed Steel conduit as required shall be used.

6.02.05 Providing and fixing suitable size of telephone tag boxes with cover (on surface/ in recess) including supplying & fixing screw less tag block complete with back mount frame grommets, disconnection module

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- inside the box, including fixing the box making termination of pairs shall be used.
- 6.02.06 Supplying and drawing following 2 pair, 0.5 sq. mm FRLS PVC insulated copper conductor, un armored telephone wire in the surface/ recessed Steel conduit as required shall be used.
- 6.02.07 Supplying and drawing following co-axial TV cable RG-6 grade, 0.7 mm solid copper conductor PE insulated, shielded with fine tinned copper braid and protection with PVC sheathed in the surface/ recessed steel conduit as required shall be used.
- 6.02.08 Supply and erection of 75mmx75mm (nominal size) modular box with modular type RJ-11 telephone socket, TV socket in surface/ recessed manner etc. as required shall be used.
- 6.02.09 Suitable no of Pipe/Plate earthing shall be as per IS: 3033. Earthing with 6 sq. mm PVC FRLS copper wire for lighting panel/MDB and GI strip with suitable capacity for main distribution board.
- 6.02.10 Suitable no of lightning conductor GI finial with horizontal & vertical GI tape 20 mmX3mm thick on surface of wall or parapet including necessary Pipe/Plate earthing shall be as per IS: 3033.
- 6.02.11 MCCB/MCB of suitable capacity & RCCB-30mA should be part of the Double door lighting panel/ distribution panel for safety purposes complete as per design & detaining. Earthing of lighting poles & fixtures shall be as per IS.
- 6.02.12 Double door Main distribution with energy meter and sub distribution board with suitable capacity incoming & out- going modules with a provision of emergency supply. Suitable capacity & rating of MCCB/MCB for over current & short circuit protection.
- 6.02.13 Air Conditioning power points shall be provided with 4 sq mm or suitable capacity of FRLS PVC insulated copper conductor single core cable in surface/recessed Steel conduit along with 1 No 4 Sq.mm FRLS PVC insulated copper conductor single core cable for loop earthing including

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providing and fixing 20A, 240 volts modular type socket outlet as required with switch.

6.03.00 LED Lighting System:

6.03.01 Supplying, installation, testing & commissioning of LED Light fixtures with lamp as required and as per design detail etc complete with driver etc shall be used. Light fixtures of Philips, Bajaj, Surya, Wipro or approved make shall be used, subject to owner QA approval.

6.03.02 The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall be not less than 70 Lm/W. Suitable heat sink shall be designed & shall be provided in the luminaire. The LED used in the luminaires shall have colour rendering index (CRI) of Min 65. The LED luminaire shall have minimum life of 45,000 burning hours with 80% of lumen maintenance at the end of the life.

6.03.03 The beam angle for LED chip shall be 120 degrees. The max. Junction temperature of LED shall be 85 deg C, further the lumen maintenance at this temperature shall be min 90%. The THD of LED Luminaires shall be less than 10%. Further the EMC shall be as per IS 14700. The power factor of the luminaire shall not be less than 0.9. The marking on luminaire & safety requirements of luminaire shall be as per IS standards. Suitable heat sink with proper thermal management shall be designed & provided in the luminaire.

6.03.04 Care shall be taken in the design that there is no water stagnation anywhere. The entire housing shall be dust and water proof protection as per IS 12063.

6.03.05 Driver Circuit: LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED manufacturer.

6.03.06 LED Drivers may have following control & protections:-

- Suitable precision current control of LED.
- Open Circuit Protection
- Short Circuit Protection
- Over Temperature Protection
- Overload Protection.
- Over Voltage Protection.

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6.04.00 Fans-Ceiling Fans (BLDC, 5 star rated), Wall Mounted Fans & Exhaust Fans

6.04.01 Supplying and fixing of min 200 mm dia with 1350-1450 RPM exhaust fan(Plastic Body) for toilets and 225/230mm dia with 1350-1450 RPM exhaust fan(Metal body) for kitchen for fresh air circulation, suitable for operation on 230 volts, 50 Hz, single phase AC supply complete with grouting bolts, gravity operated louvers, including making the hole to suit the size of the above fan, making good the damage, connection, testing, commissioning etc. complete as required of reputed make as owner QA approved.

6.04.02 Supply and fixing of of 1200mm sweep (as per drawing), BEE 5 star rated Ceiling fan with BLDC motor with remote or electronic regulator suitable for operation on 230V, 50 Hz, single phase AC supply complete with groutings, bolts, interconnections etc. as required shall be used of reputed make as owner QA approved.

6.04.03 Supply and fixing of 400 mm sweep Bracket fan with sweep & speed control through pull cot suitable for single phase, 230V, AC supply complete with motor, capacitor mounting brackets, including all accessories and of reputed make as owner QA approved.

6.05.00 Main Distribution Board , Meter board with energy meter and Lighting Panel

6.05.01 Main distribution board and Sub Distribution boards with MCB/MCCB of suitable rating for I/C and O/G shall be provided. Lighting panel shall have MCB with RCCB of suitable rating.

6.05.02 **Ammeter & Volt metre with necessary selection switch and indicating lamps provision to be provided on Main Distribution board. LT Distribution boards/ Meter Board with energy meter**

6.05.03 Codes and Standards

Distribution boards & components shall conform to the requirements of the latest revisions including amendments of the following codes and standards:

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- IS: 8623 Specification for factory built assemblies of switchgear and control gear for voltages upto and including 1000V AC/1200V DC.
- IS: 13947-I General requirements for switchgear and control gear for voltages not exceeding 1000V.
- IS: 13947-I Degree of Protection provided by enclosures for low voltage switchgear and control gear.
- IS: 10118 Code of practice for selection, installation and maintenance of Switchgear & control gear
- IS: 9224 HRC Cartridge fuses.
- IS: 13947 Air break switches, Air break disconnectors, Air break disconnector and fuse combination units for voltages not exceeding 1000 V AC or 1200V DC.
- IS: 6005 Code of practice for phosphating of iron & steel.

6.05.04 General Description

- a) The panel shall be metal enclosed, single/double front, indoor, floor/wall mounted with compartmentalized construction type. The panel shall be designed for a degree of protection of IP 52. The panel height shall not exceed 2100mm. In case, horizontal bus bars at the top are provided, panel height up to 2450mm is also permitted.
- b) The panel shall be fabricated using pressed and shaped cold rolled sheet steel of thickness not less than 2.0mm. Frames shall be enclosed by cold rolled sheet steel of thickness not less than 1.6mm. Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6mm. Stiffeners shall be provided wherever necessary.
- c) All cut outs & covers shall be provided with synthetic rubber gaskets.
- d) The panel shall be divided into distinct vertical sections each comprising of
 - (i) A completely enclosed bus bar compartment for running horizontal and vertical bus bars.
 - (ii) Completely enclosed compartment one for each circuit for housing MCCB/MCB unit etc.
 - (iii) A compartment alley for power and control cables of at least 175 mm width covering entire height.

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- e) The front of each compartment shall be provided with the hinged single leaf door with locking facilities.
- f) Provision for installing Energy meters inside the panel on all outgoing feeders for Residential buildings and on incoming feeder for other buildings or as specified in Drawings.
- g) Panel shall be provided with suitable fixing facilities.
- h) MCCB/MCB with or without RCCB (as per BOQ) units shall be of fixed type, each feeder shall have compartmentalized construction.
- i) Cable entry shall be from bottom / top as required
- j) The panel shall be provided with three phase buses and a neutral bus bar of copper / aluminium sections throughout the length of DB/MB panel and shall be adequately supported and braced. Maximum temperature rise of bus bars and bus bar connections while carrying rated current shall not exceed 40 degree C. over an ambient of 50 degree C.
- k) The minimum clearance in air between phases and between phase and earth for the entire run of bus bars, bus bar connections shall be 25mm. Bus bar support insulators shall be made of non hygroscopic non combustible track resistant & high strength type sheet moulded compound or equivalent type fiber glass moulded material.
- l) All busbars shall be colour coded as per IS: 375.
- m) A galvanized steel earth bus shall be provided at the bottom of the panel throughout the length. The size of GI bus shall be equal to half the cross sectional area of phase bus.
- n) The outgoing feeders shall be MCCBs/MCBs.
- o) MCCBs shall conform to IS:13947(Part-2) in all respects. MCCBs shall be suitable for 3 phase 415V or single phase 230V AC. MCCBs shall be of thermo magnetic or static release type.
- p) Indicating lamps shall be of the panel mounting, Cluster LED type and shall have escutcheon plates marked with its function wherever

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necessary. The colour of the translucent lamp cover shall be Red for 'ON' and Green for 'OFF'.

6.05.05 Name Plates and Labels

- (a) Panel and all modules shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation.
- (b) All name plates shall be of non rusting metal or 3 Ply lamicaid with white engraved lettering on black background. Inscriptions and lettering sizes shall be subject to Owner's approval
- (c) Suitable stenciled paint mark shall be provided inside the panel/module identification of all equipment in addition to the plastic sticker tables, if provided. These labels shall be positioned so as to be clearly visible and shall have the device number, as mentioned in module wiring drawings.

6.05.06 Power Cables/Conduits Termination

- (a) Cable termination compartment and arrangement for power cables shall be suitable for 1100 V grade standard aluminium conductor, armoured, XLPE insulated and PVC sheathed. Cables.
- (b) All necessary cable terminating accessories such as Gland plates, supporting clamps and brackets, power cable lugs, hardware etc. shall be provided by the bidder and to be included in the quoted price of Distribution Board.
- (c) The gland plates shall be removable type and shall cover the entire cable alley. Bidder shall ensure that sufficient space is provided for all cable glands. For all single core cables, gland plates shall be of non magnetic material.
- (d) Suitable arrangement and space shall be provided for connection of outgoing feeders in conduits, if required.

6.05.07 Painting

All sheet steel work shall be pretreated, in tanks, in accordance with IS:6005. The phosphate coating shall be Class-C as specified in IS: 6005. The phosphated surfaces shall be rinsed and passivated prior to

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application of stoved lead oxide primer coating. After primer application, Electrostatic powder painting shall be applied. Finishing paint shade shall be RAL 9002 unless otherwise required by the owner. The paint thickness shall not be less than 60 microns. Finished parts shall be coated by pealable compound by spraying method to protect the finished surfaces from scratches, grease dirt and oily spots during testing, transportation, handing and erection. All hardware shall be Nickle/Cadmium plated. The pad locking plate shall also be suitably painted to avoid rusting.

6.05.08 Lighting Panels

- 6.05.08.01 Lighting panels shall be metal enclosed, single front, indoor, recess/surface mounting type constructed out of 1.6 mm thick CRCA sheet steel and load bearing members constructed out of 2.0 mm thick CRCA sheet steel. The main door shall be hinged and the panel shall be gasketed with degree of protection of IP-42. The panel shall be provided with terminal blocks for incoming and outgoing circuits, earthing terminals, M.S. mounting brackets suitable for surface mounting on wall/column/structure(as applicable), latching arrangement for door, circuit directory plate & circuit diagram fitted on the inside of the door etc. Removable gland plates shall be provided for entry of cables/conduits. The quoted price of lighting panel shall include cable glands and lugs of suitable sizes for all incoming & outgoing feeders.
- 6.05.08.02 Wiring inside the panel shall be carried out with 1100 V grade. PVC insulated stranded copper wires of adequate size. On both ends of each wire engraved identification ferrules shall be provided.
- 6.05.08.03 The Lighting panels shall be of three phase type with incoming MCCB/MCB with RCCB and outgoing MCBs as per requirement. All MCCBs/MCBs/RCCBs/Switches etc. shall be mounted inside the panel with the front cover. Only the operating knobs of MCCBs/MCBs/RCCBs etc., shall project out of the front cover, through neatly machine made opening, for safe operation against accidental contact. The front cover with MCCBs/MCBs/RCCBs shall be covered by the hinged main door. The bus-bars shall be made of solid electrolytic copper of appropriate cross-section with plug-in or bolted type MCCBs/MCBs/RCCBs. Neutral bus-bars shall be provided for adequate no. of terminals as required. An earth bar of similar size as the neutral bar shall also be provided. Phase barriers shall be fitted and all live parts shall be adequately covered by the front cover. Adequate clearance shall be provided between phases and between phase & earth.

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- 6.05.08.04 Equipment mounted inside the panel shall be provided with individual labels with equipment designation/rating. Main door of the panel shall be provided with label engraved with designation of the panel as furnished by the employer. Labels shall be made of 3 ply lamicaid /engraved PVC having white letters on black background.
- 6.05.08.05 Adequate space shall be provided for terminating incoming & outgoing cables/wires. Terminal blocks shall be of 750 V grade, clip-on stud type for cables and screw type moulded in melamine for wires, suitable for terminating multicore stranded aluminium / copper conductor cables/wires of the required sizes for incoming/outgoing feeders. All terminals shall be shrouded, numbered and provided with identification strip for the feeders.
- 6.05.08.06 MCB's shall be current limiting type with magnetic and thermal release suitable for manual closing and automatic tripping under fault condition.
- 6.05.08.07 MCB's shall have short circuit interrupting capacity of 9 KA rms. MCB knob shall be marked with ON/OFF indication. A trip free release shall be provided to ensure tripping on fault even if the knob is held in ON position. MCB terminal shall be shrouded to avoid accidental contact.
- 6.05.08.08 The exterior side of panel, shall be powder coated with smoke grey, shade RAL9002 and the interior side of the panels shall be white.
- 6.05.08.09 RCCB's shall be Electro-mechanical, self immuned type having inbuilt filter to avoid nuisance tripping.
- 6.05.09 Cable glands & lugs**
- 6.05.09.01 The cost of cable glands and lugs shall be included in the quoted price of the respective Meter Board/Distribution Board/Lighting Panel for which these are to be provided for termination of cables/wires.
- 6.05.09.02 Cable glands shall be of compression type, made of tin plated heavy duty brass castings & machine finished. Glands shall be of robust construction capable of clamping cable & cable armour, firmly without injury to the cable. All washers & hardware shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene/synthetic rubber of tested quality.
- 6.05.09.03 Cable lugs shall be aluminum alloy solderless crimping type conforming to IS: 8309 suitable for aluminum conductors. Crimping of terminals shall be done by using corrosion inhibitory compound. Cable lugs for copper

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cables shall be made of tinned copper and shall be provided with insulating sleeve.

6.05.10 Cables & Wires

6.05.10.01 PVC wires shall be of 1.1 KV grade, PVC insulated, single core, stranded, copper / aluminium conductor conforming to IS: 694. The wires shall be colour coded for R.Y.B. phases and neutral

6.06.00 ENERGY METERS

6.06.01 BASIC TECHNICAL FEATURES

6.06.02 The energy meters shall be static, conforming to IEC 61036 / IS 13779 and suitable for active energy (kWh) measurement of AC, 1 phase, 240V, 2 wire system and/or AC, 3 phase, 4 wire, 415V system as applicable.

6.06.03 Current rating for the meters shall be based on the Bill of Quantity. Wherever it is not feasible to provide the direct reading energy meters, CT-operated energy meters shall be provided. Supply of CTs for such energy meters shall also be in bidder's scope. The CT parameters shall be as follows

Ratio	:	As per the Bill of Quantities
Accuracy Class	:	1.0
ISF	:	5

6.06.04 Energy Meters shall have accuracy of the energy measurement of Class 1.0 for active energy. The accuracy shall not drift with time. The measured energy shall be fundamental including harmonics.

6.06.05 Energy Meters shall have LCD/LED type of display for the cumulative energy measured. The LCD/LED display shall have minimum 6 (six) digits including one decimal point programmed to 1/10th of kWh. The cover shall have a transparent viewing window made of scratch resistant and break resistant transparent material for clear reading of display.

6.06.06 Each meter shall have a unique identification code provided by Owner and shall be marked permanently on the front and also in the non-volatile memory.

6.06.07 The meter shall operate with power drawn from the AC supply.

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- 6.06.08 Energy Meters shall have a non-contact type optical port on the front of the meter for data collection through a portable hand-held Meter Reading Instrument to be provided by the Bidder. The quantity of the hand-held units shall be as per Bill of Quantity. The data so collected once in a month shall be transferred to one common IBM compatible PC to be supplied by the Bidder. In case the non-contact optical port is not provided for data collection through a hand held Meter Reading Instrument, a RS232 port, working on an open protocol with a laptop computer (to be supplied by the bidder) can be offered in lieu of MRI.
- 6.06.09 The PC shall be with 19" digital LED colour monitor, i5, 2nd generation, DDR2, 3.3GHz processor or better, 500GB HDD, 4GB RAM, 52 x DVD-RW, multi-media capability, key board/mouse, heavy-duty laser jet printer and UPS. The PC shall be provided with certified copy of operating system and also other necessary software for complete billing system.
- 6.06.10 The meter shall have means to test accuracy at site.
- 6.06.11 The meter should operate satisfactorily at the following operating range of parameters:
 Temperature : 0 to 55 °C.
 Frequency : 50 Hz + 5%
 Voltage : 240 V + 10% or 415V+10%
 Humidity : As per Clause 8.2 of IS 13779
- 6.06.12 The meter shall be housed in a safe, high grade engineering plastic / polycarbonate casing conforming to IP51 degree of protection for protection against ingress of dust, moisture and vermin.
- 6.06.13 The meter shall also withstand, without any damage or mal-operation, reasonable mechanical shocks, earthquake forces, ambient temperature variations, relative humidity etc. in accordance with IEC-1036.
- 6.06.14 The energy meters shall meet the starting current and maximum continuous current requirements as specified in IS 13779 / IEC1036. Energy Meters shall be capable of recording at least the following tamper conditions:
 a) Current Reversal
 b) Phase – Neutral Interchange
 c) Power Outage
 d) Meter Cover Open

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- 6.06.15 All insulating material used in the construction of meters shall be non-hygroscopic, non-aging and of tested quality. All parts that are likely to develop corrosion shall be effectively protected against corrosion during operating life by providing suitable protective coating.
- 6.06.16 The meter shall be supplied with a transparent extended terminal block cover (ETBC). The meter-base, meter cover, terminal block and ETBC shall be made of unbreakable, high grade, fire resistant, reinforced, non-flammable, polycarbonate or equivalent high grade and good quality engineering plastic.
- 6.06.17 The meter terminal block shall be made of high grade non-hygroscopic, fire retardant, low tracking, reinforced poly-carbonate (not Bakelite) or equivalent high grade engineering plastic which should form an extension of the meter case
- 6.06.18 The meters shall be housed in wall-mounted / floor mounted meter boxes. The meter boxes shall be of painted sheet steel or aluminium. The thickness of sheet steel shall be 2mm cold rolled or 2.5mm hot rolled. The thickness of aluminium shall be 3mm and shall provide rigidity. Top of the box shall be sloped towards the rear of the box. The paint shall be of grey shade RAL9002 on the outside and white shade RAL9010 inside. The degree of protection for the meter boxes shall be at least IP55 as per IS2147.
- 6.06.19 The size of the meter box shall provide sufficient clearances for carrying out any maintenance work inside the meter box.
- 6.06.20 Each meter box shall be provided with two earthing pads to receive 75x12mm² GS flat. The connection shall be bolted type with two bolts per pad.
- 6.06.21 The bidder shall prepare the engineering drawing of the meter boxes as per the site requirements and shall submit the same to owner for approval before manufacture. The bidder shall interact with owner site engineers for finalization of meter box arrangement.
- 6.06.22 Bidder shall provide check meters along with meter boxes at Lighting Panels of power supply distribution system. The total quantity of check meters for bidding purpose has been indicated in the Bill of Quantities.
- 6.06.23 SOFTWARES**
Licensed copies of following software shall be supplied as per the Bill of Quantities:

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- A) Latest version of Software for Meter Reading Instrument for downloading meter readings and transferring the readings to the base computer. The software shall be user-friendly and shall be installed on all the Meter Reading Instruments being supplied in this contract.
- B) Software for the Base Computer: Windows 8 based user friendly and interactive software, having capability to carry out following tasks:
- Shall be capable of communicating with the Meter Reading Instrument for downloading the meter data from Meter Reading Instrument to the base computer.
 - Shall be capable of converting the meter data received from the Meter Reading Instrument into user-defined formats.
 - Shall be capable of generating the following:
 - a) Consumer Bills
 - b) Billing Reports
 - c) Tamper Reports
- The format for consumer bills and other reports shall be finalized during detailed engineering.

6.06.24 INSTALLATION AND COMMISSIONING

- 6.06.24.01 The static energy meters as specified in this specification shall be installed at the premises of various consumers at the locations indicated by Owner.
- 6.06.24.02 The bidder shall be responsible for the total installation and commissioning of all the meters to the satisfaction of the Owner.
- 6.06.24.03 As a part of commissioning of Meter Reading Instrument and the Base Computer Station, the bidder shall install the software specified in this specification in all the Meter Reading Instruments and the base computers and fully commission the total meter reading scheme. The bidder shall also impart the necessary training to Owner's engineers for successful operation of Meter Reading Scheme.

6.07.00 Geyser specifications.

- 15Litre plastic body Adjustable Temperature Thermostat storage water heater
- 5Star rated

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- Rust proof body
- Min 6.5 Bar pressure withstanding capacity
- Tank should be state of the art and have necessary protection against Hard Water, rust and corrosion preferably Magnesium Anode/Glass Lined Coated
- All inlet & out let water piping connection to geyser.
- Safety/protection against high temperature, pressure with cutout , thermostat and safety valve
- PUF insulation
- Electrical wiring & necessary socket & plug arrangement.

6.08.00

Exclusions:

- D G Set with AMF Panel.
- Telephone, TV & DTH instrument, TV/DTH DB and server DB.

6.09.00

Approved makes

SNo.	Description	Approved Makes
1	Steel conduit	BIS Licensee/ISI marked.
2	Switch/Socket along switch box	Anchor/Crabtree/Legrand
3	LT Power/control cables	Universal cable Ltd/Nicco/Torrent Cable/In cab/Hindustan Power Product Ltd/KEI Industries/Paramount Cable/Poly Cab wires Pvt.Ltd/Gemscabs/Cords Cables/Havells India Ltd/Sri ram Cables/Ravin cables/Finolex/Termocables/Gupta Power/R.R Kabel/Elkay Telelink/Delton cables Ltd.
4	Lighting Fixtures	Surya/Wipro/Bajaj/Philips.
5	Ceiling Fans & exhaust fans	Crompton/Orient/Khaitan/Bajaj.
6	LT PVC copper wires	BIS approved

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7	Telephone wires, sockets, LAN cables, Communication cables	DOT approved source.
8	Lighting Panels/Meter boards/ feeder pillars/ LPBS	L&T/Positronics/Havells/Jakson/Switching circuit/Sarvana Switch gear/ C&S/GEII/ICA/ISC/Siemens/Avaid's Technovators /Jasper/Vidyut Control/Concurrent control systems/Unilec/Pyro tech/Makel.
9	Geyser	AO Smith / Havells / Crompton Greaves / Racold

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Fire Detection & Protection System

- 7.01.00** The fire detection and protection system shall cover the pre-engineered accommodation , 16 single room , 6 suite room accommodation , dining , kitchen store utility at GNI PROJECT.
- 7.01.01** The complete fire detection and protection system shall be in line with the requirements of National Building Code (NBC) and rules & regulations of Local Fire Authority as per the statutory regulations applicable for obtaining the occupation certificate from the Local Development / Fire Authority.
- 7.01.02** All material used in the works shall have Bureau of Indian Standards valid certification stamped, marked or cast on the material in an acceptable and approved manner.
- 7.00.03** It is the sole responsibility of the bidder to get the approval of the Local Fire Authority for the work done by him and nothing extra shall be payable including the official and other charges
- 7.00.04** The Bidder shall also provide all material, equipment and services which may not be specifically stated in the specifications but are required for completeness of the equipment/systems furnished by the Bidder and for meeting the intent and requirements of the specification.
- 7.00.05** Work to be carried out in accordance to and following GTR (General Technical Requirements), ECC (Erection Conditions of Contract) & GCC (General Conditions of Contract).
- 7.02.00** **SCOPE OF WORK**
- 7.02.01** The scope of work includes design, engineering, supply, installation, testing and commissioning of all the systems and equipment detailed below.
- a) Fire water storage tank at terrace of minimum capacity 5000 litres for the pre-engineered Blocks will be in scope of civil work against respective Items in civil work and booster pump along with drive motor each of minimum capacity 450 LPM @ 3.5 kg/cm² (g) as per NBC will be in

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Bidders scope.

b) Wet Down comer for fire hose reels at various landings of buildings along with all accessories.

c) Piping, valves, pipe protection, painting, etc.

d) Civil works associated with complete fire detection & protection system

e) Analog addressable fire detection and alarm system in all rooms and lobby/corridor area of each block, consisting of multi sensor detectors, manual call points, hooters, cabling, fire alarm panel etc.

7.02.02 Bidder shall provide fire alarm panel common for all the Blocks.

7.02.03 Fire alarm panel shall include but not limited to the following elements:
Analog addressable fire detection and alarm system panel with Master processor module, monitoring modules, supervisory control modules, input/output modules, auxiliary relay modules, network modules, inbuilt printer and power supply system.

7.02.04 Fire alarm panel shall be placed inside a wall mounted panel with glass plate in front.

7.02.05 Power supply system shall consist of 1x100% battery charger and 1x100% battery suitable for providing backup of 24 hours & 30 minutes (in alarm conditions) for fire alarm panel.

7.02.06 Detector cables inside the building shall be laid through HDPE conduits to prevent damage.

7.02.07 Software & hardware as required for providing a complete functioning of the system including diagnostics.

7.02.08 Level gauge for each tank shall be provided. Accuracy of level gauge shall be +/-2% over full range

7.02.09 Local starter boxes shall be provided for each pump. However, for remote operation of pumps push button station shall be provided at ground floor of each block.

7.02.10 Portable fire extinguishers

7.02.11 Fire tanks and filling line of fire tank upto terrace.

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- 7.02.12 Any other system not covered above but required as per National Building Code or local fire authorities shall also be deemed to be included in bidder's scope of supply.
- 7.02.13 Mandatory spares to be supplied for FDPS is attached at **Appendix-1**.
- 7.03.00 Technical Requirement: Fire Detection & Protection System**
- 7.03.01 Fire Detection and protection system for specified buildings shall be in line with the requirements of National building code and shall comply with all the requirements of Local fire authorities.
- 7.03.02 All equipments/ components of complete fire detection & protection system shall have the approval from one of the following:
- a) Underwriters Laboratories of USA
 - b) LPCB –UK
 - c) FM-USA
 - d) BIS (for pumps & valves)
- 7.03.03 **Fire Hose Reels**
- Bidder shall provide standard fire hose reels with 20 mm dia, high pressure rubber hose 36.5m long with gunmetal nozzle and control valve, shut-off valve, all mounted on circular hose reel drum of heavy duty mild steel construction and cast iron brackets. Hose reel shall be directly connected to downcomer. Hose reel shall confirm to IS: 884 and rubber hose to IS: 5132
- 7.03.04 **Hose Cabinets**
- Hose cabinets shall be fabricated from 16 gauge M.S. sheet of fully welded construction with hinged double front door partially glazed (4 mm thick) with locking arrangement, stove enameled fire red paint with "FIRE HOSE" written on it prominently. Fire hose shall be suitable to accommodate one fire hose reel & accessories, etc. Approximate size shall be 0.9M X 2.1M.
- 7.03.05 **Pipes**
- All pipes within and outside the building in exposed locations and shafts

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including buried under floor shall be M.S. pipes as follows:

Pipes 150 mm dia and below as per IS:1239 (Part-I)

Pipes 200 mm dia and above as per IS: 3589 Gr 410 of minimum nominal thickness of 6.3 mm. Tolerance as per code shall be applicable.

7.03.06 Pipe Fittings

For pipe fittings the material shall conform to ASTM A 234 Gr WPB or ASTM A 105 or equivalent and dimensional standard conforming to ANSI B16.11 (socket & threaded type), ANSI B16.9 (for butt welded fittings) and ANSI B16.5 (for flanges & flanged fittings) as the case may be. Further, galvanized malleable cast iron fittings as per IS:1879 or Cast iron fittings as per BS:1641 are also acceptable.

Set on set in type fittings shall not be acceptable.

Pipe fittings means tees, elbows, couplings, flanges, reducers, etc. and all such connecting devices that are needed to complete the piping work in its totality.

Screwed fittings shall be approved type malleable or cast iron with reinforced ring on all edges of the fittings suitable for screwed joints. Forged steel fittings of approved type with "V" groove for welded joints. Fabricated fittings shall not be permitted for pipe diameter 300 mm and above.

7.03.07 Valves

All valves shall be as per applicable IS/BS codes & approved by LPA / TAC accredited professionals for specific fire protection system and shall be provided with locking arrangement (with locks) in open or close condition. Further, all gate / butterfly valves of size 200 mm & above shall be provided with spur gear reduction unit.

7.03.07.01 Ball Valve

Valves 40 mm dia & below shall be heavy type nickel plated brass body

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screwed type, with chromium plated brass balls, PTFE Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm² including coupling and gunmetal handle conforming to BS:5351 with female screwed ends.

7.03.07.02 Butterfly Valves

Butterfly valves shall be cast iron body and shall be of class P.N. 1.6 tested to 20 kg/cm² with following details: The shaft shall be of EN-8 Carbon steel Built in flanged rubber seals. Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant. The seat shall be drop tight constructed by bonding resilient elasto-meter inside a rigid backing. Seat rings shall of EPDM. Built in flanges for screwed on flanged connections.

7.03.07.03 Non Return Valve (NRV)

Non return valve (swing check type) shall be of CI construction, suitable for PN-1.6 pressure with EPDM / Nitrile seat. It shall be single door swing check type of best quality.

7.03.07.04 Gate/Sluice Valve

These valves shall conform to IS: 14846 / BS: 5150 shall be of Cast Iron construction & suitable for PN-1.6 pressure.

7.03.07.05 Drain Valve

Provide 25 mm dia black steel pipe to IS: 1239 (Part-I) with 25 mm Gunmetal ball valve for draining any water in the system in low pockets.

7.03.08 Electric Driven Booster Pump

Pump shall be monoblock or single stage horizontal centrifugal single outlet with cast iron (2.5% Ni) body and dynamically balanced bronze impellers.

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Connecting shaft shall be stainless steel (SS316) with SS: 410 sleeve and grease lubricated bearings.

Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.

Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty.

Motor should be rated not to draw starting current more than 3 times the normal running current.

Motors shall be wound for class B insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fiber insulated. Motors shall conform to IS: 325.

Speed of the motor shall be compatible with the speed of the pump. Starting panel for auto start/stop of the pump.

7.03.09 **Fire Water Storage Tank**

Overhead water storage tank of RCC/HDPE of required capacity (in civil package) as per guideline of NBC shall be provided on platform for overhead tank of buildings as specified elsewhere in this document.

7.03.10 **Portable fire extinguishers as per NBC norms**

7.03.11 **Painting**

A) All Steel Surfaces (external) exposed to atmosphere (outdoor installation)

- i. Surface Preparation: The steel surfaces to be applied with painting shall be thoroughly cleaned before painting by wire brushing, air blowing, etc.
- ii. Painting: One (1) Coat of red oxide primer of thickness 30 to 35 microns followed up with three (3) coats synthetic enamel paint,

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with 25 microns as thickness of each coat.

B) All Steel Surfaces (external) inside the building (indoor installation)

- i. Surface Preparation: The steel surfaces to be applied with painting shall be thoroughly cleaned before painting by wire brushing, air blowing, etc.
- ii. Painting: One (1) Coat of red oxide primer of thickness 30 to 35 microns followed up with two (2) coats synthetic enamel paint, with 25 microns as thickness of each coat.

7.04.00 Fire Detection & Alarm System

7.04.01 Codes and Standards

7.04.01.01 The design, manufacture, testing, performance, etc. of the various components of the analog addressable fire detection and alarm system shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the bidder of this responsibility.

7.04.01.02 Unless otherwise specified, the fire detection and alarm system and the components shall conform to the latest applicable Indian or IEC Standards. Equipment complying with any other authoritative National Standards such as British, USA, etc. will also be considered, provided the parameters specified are equivalent or better than the corresponding Indian Standards.

7.04.01.03 Certified copies of test reports and approvals shall be furnished along with the Bid.

7.05.00 Approvals for Systems and Components

7.05.01 General

The Bidder shall be solely responsible for obtaining the required approval and clearance for the different components and systems of the Fire Detection and Alarm System from either of the following authorities, as

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applicable:

- a. Department of Atomic Energy (Certification of safety from Radioactivity).
- b. Central Building Research Institute, Roorkee.
- c. Central Mining Research Station, Dhanbad.
- d. Local Fire Authorities.
- e. National Building code.

7.05.02 The equipment and the system shall be of types approved by any of the following bodies, as applicable:

1. Loss Prevention Council, (LPC), U.K.
2. National Fire Protection Association, (NFPA), USA
3. Under-writer's laboratories, (UL), USA
4. Factory mutual(FM)
5. EPA, USA

7.06.00 Cables and Hardware

7.06.01 Power supply cables from source to fire alarm panel, shall be provided by the bidder. Cables for hooter/flashers etc. shall also be provided by the bidder. Power cables shall be FRLS & as per IS-1554 Part-I latest edition. All other cables that shall be required to complete the system shall be fire resistance type and shall be as per the applicable standards of UL/NFPA etc.

Note: Bidder to visit site and make the assessment of cables and hardware etc. and comply to owner requirements.

7.06.02 Specification of Instrumentation & Control Cables

7.06.03 The cable conductor size for instrumentation cable shall be of minimum 0.5-sq.mm and for control cable of minimum 1.5 sq.mm, 2.5-sq.mm size and 4.0-sq.mm high conductivity, multi-stranded (7 strands) copper depending on application.

7.06.04 The insulation of detector cables shall be from fire resistant material and as per IEC/UL/NFPA Standards. The unarmored cable shall be provided

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for use in inside building & armored cable for use in outside building. Each cable shall be provided with marking of manufacturer's name, insulation material, and conductor sizes, no of pairs/cores, voltage ratings, type of cable, year of manufacture, package name & number etc at each meter. Progressive sequential marking of the length of the cable at every one meter & progressive markings to read 'FR or FRLS' at every 5 meters shall be provided on the outer sheath of cables.

- 7.06.05 Voltage grade of detector cables for use in 24vdc circuits shall be minimum 500 volts as per IEC.
- 7.06.06 The cables shall meet the following minimum requirements:
- (i) An Oxygen index of not less than 29% and a Temperature index of not less than 250 deg.C as per ASTM-D-2863.
 - (ii) Maximum acid gas generation by weight as per IEC-60754-I shall not be more than 20%.
 - (iii) Smoke Density Rating shall not be more than 60% during Smoke Density Test as per ASTM-D-2843. The results of smoke density test shall be plotted on a curve indicating light absorption vs. time as per ASTM-D-2843. The average area under the curve (smoke density rating) shall not be more than 60%.
 - (iv) Complete cable assembly shall pass Swedish Chimney test as per SEN-4241475 and flammability test as per IEEE-383.
- 7.06.07 All cables shall be suitable for continuous operation at 70 deg.C, minimum except for high temperature resistant teflon insulated cables which shall be suitable for continuous operation at 205 deg.C. The cables shall be suitable for laying in wet or dry locations in trays, conduits, ducts, trenches and under ground buried installations.
- 7.06.08 All prefabricated cables shall have 10% spare cores, which will not be connected to pin connectors.
- 7.06.09 All control cables shall be Multi core having overall shielding and voltage grade shall be 1100 V.

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7.07.00 Specification of Fiber Optical Cables

7.07.01 Fiber Optic cable shall be 4/8/12 core, corrugated steel taped armoured, fully water blocked with dielectric central member for outdoor/indoor application so as to prevent any physical damage. The cable shall have multiple single-mode fibres as required by the communications system so as to avoid the usage of any repeaters. The core and cladding diameter shall be 9 +/- 1 micro-meters and 125 +/- 1 micro- meters respectively. The outer sheath shall be Flame Retardant, UV resistant properties and identified with the manufacturer's name on it.

7.07.02 The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Steel central member, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled. The cable shall be suitable for a maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum. The operating temperature shall be –20 deg. C to 70 deg.C

7.07.03 All testing of the fiber optic cable being supplied shall be as per the relevant IEC, EIA and other international standards.

7.07.04 Bidder to ensure that minimum hundred (100) percent cores are kept as spares in all types of optical fiber cables.

7.07.05 Conduits

All rigid conduits, couplings and elbows shall be hot dipped galvanised rigid mild steel in accordance with IS: 9357 Part-I (1980) and Part-II (1981). The conduit interior and exterior surfaces shall have continuous zinc coating with an overcoat of transparent enamel lacker or zinc chromate. Flexible conduit shall be heat resistant lead coated steel, water leak, fire and rust proof. The temperature rating of flexible conduit shall be suitable for actual application

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7.08.00 Power Supply for Fire Alarm Panel

7.08.01 Power supply system comprising of 1 x 100% charger and 1 x 100% battery shall be provided for each fire alarm panel .The batteries for fire alarm system shall be sealed maintenance free lead acid type. The battery backup for each fire alarm panel and repeater alarm panel shall be 24 hours and 30 minutes (in alarm conditions). At least 25% of the devices shall be considered to be active in alarm conditions. The battery charger shall be sized to meet connected load requirements and keep the connected batteries full charged (Float Mode). Furthermore, the charger shall be sized to enable the boost charge of a fully discharged battery in 10 hours while feeding the load.

7.08.02 The battery shall be designed as per relevant IEEE standard. For battery sizing calculation, an aging factor of 0.8, a temperature correction factor (based on temperature of 4 deg. C), voltage drop of 2V in cables. Capacity factor, Float Correction Factor, as per Battery Supplier Standard, shall be taken into consideration, if applicable and ambient temperature shall be considered as the electrolytic temperature. The sizing of the battery shall be as approved by Employer during detailed engineering.

7.08.03 The battery chargers and battery shall be placed at a suitable location inside the fire alarm panel with partitions.

7.09.00 Control Cabinets / Panel

7.09.01 The panel cabinet shall be wall mounted with glass plate in front. The panel shall be of IP-54 protection class (for ventilated enclosure, IP-42 is also acceptable). The Bidder shall ensure that the abnormal temperature rise, during normal operation is prevented by careful design. If blowers are required for satisfactory system operation, ventilation blowers shall be furnished as required by the equipment design. Suitable louvers with wire mesh shall be provided on the cabinet.

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- 7.09.02 The cabinet shall be constructed with minimum 2 mm thick steel plate frame and 1.6 mm thick CRCA steel sheet or as per supplier's standard practice for similar applications..
- 7.09.03 Two spray coats of inhibitive epoxy primer-surface shall be applied to all exterior and interior surfaces. A minimum of 2 spray coats of final finish colour shall be applied to all surfaces. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2 mm and 50 microns for sheet thickness of 1.6 mm. The finish colors for exterior and interior surfaces shall conform to following shades:
Exterior:- As per RAL 9002 to be finalized during detailed engineering.
Interior:- Same as above.
- 7.09.04 Paint films which show sags, checks or other imperfections shall not be acceptable.
- 8.00.00 Detection System**
- 8.01.00 General requirements for all types of Detectors**
- 8.01.01 Detectors shall be housed or mounted in suitable enclosure in such a way that their performance is in no way affected. Special maintenance procedures if any required for the satisfactory operation of the detectors shall be clearly stated in the bid.
- 8.01.02 Necessary mounting accessories shall be provided for all the detectors.
- 8.01.03 Detectors shall preferably be designed as plug-in units, which fit into various bases according to place and type of mounting. This would also enable interchangeability.
- 8.01.04 Detectors shall be provided with the necessary compression type cable terminating glands for the incoming cables of flameproof type or PVC/metallic flexible/rigid conduits.
- 8.01.05 Depending upon the environmental conditions in which detectors are installed, chlorinated rubber based or epoxy or equivalent paint shall be

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- used for finishing the surface of the enclosure.
- 8.01.06 The coverage or the zone of protection afforded by the detector and recommended height of mounting shall be furnished by the Bidder. The bidder shall furnish the test certificate in support of this.
- 8.01.07 Any metal parts used for detector construction shall be inherently resistant to corrosion or shall be plated or otherwise suitably treated to afford protection against corrosion. The plating or treatment shall in no way affect the detector performance.
- 8.01.08 Any plastic material or any sealing compound used in the detector shall be such as it will not deform or fail under the maximum temperature to be expected.
- 8.01.09 No detector shall contain any moving parts subject to wear and tear and must be able to operate afresh after each alarm release, without its exchange or adjustment.
- 8.01.10 Adequate compensation and considerations shall be made for effects for wind velocities such as air-conditioning system and exhaust fans where dilution of particles of combustion is greater.
- 8.01.11 The exact location of detectors shall be coordinated with other services like air-conditioning grills, light fittings, cable trays etc. to provide aesthetically pleasing appearance. The return air paths of air-conditioning shall be avoided for detector location.
- 8.01.12 The detectors shall not be affected by temperature, humidity; air flow or by drift failures and shall not give any false alarm due to above.
- 8.01.13 The detectors shall not be sensitive to vibrations. Any special mounting arrangements required to counteract vibration shall be included in the bidder scope.
- 8.01.14 The minimum number of detectors shall be as per the BOM. The quantity of smoke detectors in each zone indicated in BOM is based on a coverage factor of 25-sq. meter per detector. However, the actual quantity of detectors required, taking into consideration obstructions due to floor

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beams, ventilation, doors, windows etc., shall be worked out and supplied (based on the actual layout) and installed by the bidder. Any increase in quantity of detectors over and above the quantity specified in BOM due to such layout aspects shall be paid to bidder.

8.01.15 The detectors shall not give false alarm due to high humidity, temperature, and velocity of air in the surroundings and static electricity conditions.

8.02.00 Addressable Analog Intelligent Detectors

8.02.01 In addition to the features specified under the item General requirements for all types of Detectors, the Addressable Analog Intelligent Detectors shall be provided with the following features:

1. Detectors not specifically listed for sensitivity testing from the control panel are not acceptable due to the expense involved with manual testing as required by NFPA 72E.
2. The detector shall be suitable for two-wire operation and two-way communication on the intelligent analog signaling circuit.
3. The detector shall display a steady LED when in the Alarm State. The LED shall flash when in stand by or normal mode.
4. Each detector in a loop shall have short circuit isolator suitable for style-7 wiring as per NFPA-72.
5. Address and sensitivity assignments shall be set preferably electronically. However, dip switches / rotary switches for the same are acceptable. The detectors shall be assigned a sensitivity level based on environment, time of day or any programmable function as required by the system user, and shall respond at that level whether in the "on line" or "default" mode.
6. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system.
7. The detectors furnished shall be listed for use in environments as

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covered by Factory Mutual and UL and shall be installed according to the requirements of NFPA 72E for open area coverage.

8.03.00 Multisensor Detectors

- 8.03.01 The detectors shall be sensitive to very low smoke densities of the order of say 0.05 g/m³. Also it shall be possible to adjust this sensitivity on a step less basis over a range so that the optimum sensitivity could be selected at site to suit the conditions of installations. The coverage area of the smoke detection under standard NFPA test conditions shall not be less than 80-90m².
- 8.03.02 The Multi sensor detectors shall incorporate a heat detection element and a photoelectric detection element. Both the elements shall be incorporated in a single unit. Both the elements shall be operative at all times and the fire signal shall be available from any or both elements combined together.
- 8.03.03 The detectors shall be complete with a mounting base that includes a terminal box into which the detector can be plugged in. Terminals for looping of the cables shall be provided.
- 8.03.04 All detectors shall be provided with built-in response and indicating lamps which shall give local visual indication, when it has operated. The failure of lamp shall not prevent the function of detector.
- 8.03.05 In areas such as false ceiling where detectors themselves are not easily accessible, the remote response indicators outside the enclosed areas shall be provided to indicate the fire condition.
- 8.03.06 It shall be possible to replace any type of detector head by a different type detector without requiring change in cabling/panel wiring and condition of the zone, originally covered by the detector, thereby making it possible for a multi sensor detector to be replaced by either heat, flame detector or vice versa.

8.04.00 Analog Addressable Fire Detection and Alarm System

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8.04.01 General Requirements

8.04.01.01 This specification in general covers the functional requirements, and general design aspects of Microprocessor based, Analog Addressable Fire Detection Alarm / Annunciation and Control System.

8.04.01.02 The following description intends to describe only the brief hardware and functional requirements, scope of hardware requirements etc. but the actual configuration of the system shall be in line with the prevalent normal practices in the industry and shall conform to latest product range of selected manufacturer.

8.04.01.03 The fire detection and control system offered shall be complete in all respects for the safe and reliable operation of the entire system. Any additional hardware/software than those mentioned herein required to make the system complete shall be included in the scope of the Bidder.

8.04.01.04 All the system and its equipment specifically detectors, interface modules, panels, power supply, battery chargers etc. shall be furnished from a single source and the same shall be new and latest state of the art products of manufacturer engaged in the manufacture of Integrated Microprocessor based Analog Addressable Fire Detection and Alarm System.

8.04.01.05 All equipments such as detectors, panels etc shall be approved and listed by UL/FM/LPCB/VDS.

8.04.01.06 All detectors shall be of analogue addressable type. Conventional detectors with interface modules are not acceptable.

8.04.01.07 The wiring shall be of class-A as per NFPA-72.

8.04.01.08 For devices other than detectors which do not have inbuilt isolator, bidder shall provide isolators, in case more than 5 such devices are placed consecutively in a loop. In addition to this, isolators shall be provided at the start & end of the loop.

8.04.01.09 The complete system shall include, but not be limited to the following:

a) Master system CPU.

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- b) Analog Addressable Fire Detection and Alarm System panels including alarm modules, system supervisory control modules, auxiliary output control modules etc.
- c) Inbuilt printer.
- d) Power supply modules, battery and battery charger.
- e) Analog addressable multisensor detectors.
- f) Software and hardware as required for complete operation of the system.
- g) Complete Wiring/cabling including its conduits/trays/fixtures etc.
- h) The fire alarm control panel shall function as a communication interface between central processing unit and sensors. This panel shall have facility to process the input signal and to control all the input data received from initiating and indicating devices.
- i) Fire alarm control panel shall have filters to ignore false alarm and increase sensitivity to real fire from sensors. The sensitivity of each detector should be automatically raised if detectors are gradually polluted due to dust and dirt entering inside the detector. If detectors are more polluted the control panel shall give a warning. The trouble report shall indicate the location of device requiring service.
- j) The CPU shall serve as the systems central processor. Software shall be designed specially for fire alarm annunciation system applications and shall monitor status of processing alarms according to priorities, controlling/processing communications and synchronizing all system activities.
- k) The system shall be able to recognize and indicate an alarm condition in a degrade mode of operation, in the event of processor failure or the loss of system communications to the circuit interface panels.

8.05.00 System Functional Requirements

8.05.01 The fire alarm panel shall evaluate the signals received from the detectors and shall handle the following functions:

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1. System self monitoring and fault signaling.
2. Transmission of alarm and fault signals to the fire alarm panel and as well as in the repeater panel in fire station. Further, the panel shall activate a hooter/sounder in the area locally provided with fire/smoke detection system.
3. Supervising of unauthorised removal of a detector head from its base and giving a fault alarm on the control panel.
4. Supervising and monitoring the detection cabling, to indicate fault conditions in case of open/short circuit in the wiring.
5. Supervising by a separate annunciation window, changeover from mains supply to battery supply. "Mains On" indication shall be continuously on, as long as the main supply is available.
6. Facilitating simulation of fire conditions to enable the testing of circuits (without creating actual fire) under the test mode from the fire Alarm panel.
7. The control unit shall contain all the systems main switches lamps and fuses. Switches and lamps shall be easily identified even in closed casings.
8. The cable fault shall be audio-visually annunciated on the panels. Separate hooters with different tones shall be provided for 'fault' alarms and 'fire' alarms.

8.06.00 Analog Addressable Fire Detection and Alarm System shall also meet the following functional requirements:

- i) Detectors shall be interrogated for sensitivity settings from the control panel, logged for sensitivity changes indicating the requirement for cleaning and tested by a single technician using the field test routine. Sensitivity of each of the detectors made available in the panel shall be adjustable from the panel.

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- ii) The system shall be capable of self-adjustment to compensate for the accumulation of contaminants that would change the detector sensitivity in either a more or less sensitive direction to prevent false indications or failure to alarm in the actual fire conditions. The system shall annunciate a trouble condition when any analog addressable detector reaches 80% of its alarm threshold due to gradual contamination, signaling the need for service and eliminating unwanted alarm.
- iii) The system shall be able to recognize and indicate an alarm condition in a degraded mode of operation, in the event of processor failure or the loss of system communications to the circuit interface panels.
- iv) All detectors shall incorporate internal automatic temperature compensation to overcome the effects of either high or low ambient temperatures in the installed environment on the detector sensitivity. The detectors shall be tested at a specified frequency by raising the detector sensitivity level to the alarm threshold, to check the operation of the detector without system alarming automatically by the control panel.
- v) In an alarm or trouble condition the inbuilt printer shall print the details of the alarms/troubles.

8.07.00 Panel Display Requirements.

System display shall consist of minimum 80 character back lighted alphanumeric LCD display readable at any angle. Thirty-two character customer defined custom messages shall describe the location of the active device. In addition to the above, the following features shall be available.

- a. The system shall be capable of programming to allow troubles occurred and restored in the system to be automatically removed from the display queue, eliminating the necessity for individual

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acknowledging of these events. This feature shall not affect the historical logging of events as programmed.

- b. As a minimum an LED display for “Alarm”, “Audible Silenced”, “Supervisory”, “Trouble”, “Security”, “Power On”, And “Partial System Disabled”.
- c. Touch activated membrane switches for “Alarm Acknowledge”, “Audible Silence”, “Supervisory Acknowledge”, “Security Acknowledge”, “Reset”, “Display Hold”, And “Display Next”.
- d. All membrane switches shall be tactile with audible feedback when pressed.

8.08.00 Type Test Requirements

The Bidder shall furnish the type test reports of Fire Alarm Panel, cables, Battery charger and batteries. The type tests report to be submitted to Owner for approval and report shall be on test conducted within 5 years from bid opening date of package.

8.09.00 System Testing /Commissioning

8.09.01 The complete Fire Detection and Alarm System shall be tested so that each of the above mentioned functions are demonstrated to the satisfaction of the Owner. The Bidder shall make all equipment, instruments, tools and labour required to conduct the system tests available.

8.09.02 The complete performance testing procedure shall be drawn before the tests by the Bidder and shall be approved by the Owner.

8.09.03 The bidder shall guarantee the entire system against mechanical and electrical defects for a period described in the Conditions of Contract.

8.09.04 The Bidder's scope of services shall also include two inspections of the complete system including testing and repairs if any and system re-commissioning, in full compliance with the requirements of NFPA during guarantee period of the complete fire alarm and detection system.

8.09.05 The bidder performing the above mentioned contract services shall be

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qualified and listed to maintain ongoing certification of the completed system to the UL, (USA) for specific installed system listing.

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LIST OF MANDATORY SPARES		QUANTITY IN NOS
	ITEM DESCRIPTION	
1	FIRE HOSES WITH COUPLINGS	
1.1	15m long fire hoses with end connectors	4
2	BRANCH PIPES WITH NOZZLES	
2.1	Nozzles with branch pipes & quick coupling ends	4
3	VALVES (Sluice)	
3.1	Complete valves	
3.1.1	Sluice Valve	
3.1.1.1	100 NB	2
3.2	Stem (all types), Seat ring (all types), Gaskets & Yoke Bush/Wedge Nut for Sluice Valve	
3.2.1	100 NB	1 No. Each
4	HYDRANT VALVE	
4.1	Hydrant valve complete single headed with instantaneous female coupling	2
4.2	Spindle with nuts of Hydrant valve	2
4.3	Bonnet, gland nut, rubber assembly of hydrant valve	2
4.4	Seat, check nut, washer assembly of hydrant valve	2
4.5	Rubber washer for female coupling	2
4.6	Instantaneous female coupling assembly complete for hydrant valve	2
4.7	Lock pin assembly for hydrant valve	2
5	MEASURING INSTRUMENTS	
5.1	Level Gauges	2
5.2	Pressure Gauges/ Switches	2
6	FIRE DETECTORS	
6.1	Multisensor detectors (Addressable)	10
6.2	Manual Call Points	2
7	PORTABLE EXTINGUISHERS	
7.1	Pressurized water type (9 lit. cap.) (IS:15683 operated by CO2 cartridge type)	2
7.2	CO2 type (4.5 kg. cap. IS: 15683)	2

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7.3	Dry Powder ABC type portable fire extinguisher (6kg capacity as per IS:15683)	2
8	MEASURING INSTRUMENTS	
8.1	Level Gauges	1
8.2	Pressure Gauges	1
8.3	Pressure Switches	1
9	FIRE ALARM PANEL	
9.1	Fuses	100% of population
9.2	Push Button	2 no. for each type, rating and size
9.3	All type of power supply modules including battery charging module/battery charger.	10% or 1 no. of each type & rating whichever is more
9.4	Control modules, loop cards modules, isolator cards	10% or 1 no of each type, whichever is more.
9.5	LCD display of each type unit of panel	1 No.
9.6	Cartridges for inbuilt printer of fire alarm panel	2 nos.
9.7	LED's of each type	100% of population.
9.8	Power supervision relay	2 nos. of each type.
9.9	Fire screen / alarm buzzer	1 nos. of each type
9.10	Relays of all types including overload relays	10% of each type and rating
NOTES:		
1	Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment.	
2	Any fraction of a item shall mean the next higher integer.	
3	Wherever quantity has been specified as percentage (%), the quantity of mandatory spares to be provided by bidder shall be the specified percentage (%) of the total population of the package. In case the quantity so calculated happens to be fraction, the same shall be rounded off to next higher whole number.	
4	Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc., these shall cover all the items supplied and installed and the breakup for these shall be furnished in the bid.	

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In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.

AIR CONDITIONING SYSTEM

9.00.00 SCOPE OF SUPPLY & SERVICES

9.00.01 The intent of the specification is for providing air conditioning system comprising of mainly split type air conditioning system with wall mounted type IDU's at **PRE-ENGINEERED PRE-ENGINEERED ACCOMMODATION , 16 SINGLE ROOM , 6 SUITE ROOM ACCOMMODATION , DINING , KITCHEN STORE UTILITY GNI PROJECT**. The bidder shall be responsible for Design, Engineering, Supply, Erection, Testing & Commissioning works, satisfactory completion, handing over the functioning system, as per specification.

9.00.02 The technical specification covers the technical requirements for the supply / fabrication and erection / installation of complete Air Conditioning system including Electrical System and associated civil works.

9.00.03 The bidder is requested to visit the site for which air conditioning system is being proposed before offering his bid and satisfy himself regarding any clarification / doubt with respect to the proposal. Ignorance of site conditions and any data/information shall not be accepted as a basis of claims of any compensation whatsoever in future.

9.00.04 The technical specification is intended for the general description of the works, quality and workmanship and is not intended to cover the minute details of works and workmanship. The execution of works and the workmanship shall be according to the description given in the schedule of items and relevant Indian Standards. In the absence of relevant Indian Standards, the execution of works and the workmanship shall be to the best prevailing engineering practice and/or to the recommendations of relevant British/American standards and/or as per Instructions of Engineer-in-charge.

9.01.00 SCOPE OF SUPPLY & SERVICES

9.01.01 AIR CONDITIONING SYSTEM

9.01.02 The scope of work includes Design, Engineering, Supply, Erection, Testing & Commissioning works for Air conditioning System for envisaged facilities in **PRE-ENGINEERED ACCOMMODATION , 16 SINGLE ROOM , 6**

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SUITE ROOM ACCOMMODATION , DINING , KITCHEN STORE UTILITY
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- 9.01.03** For the basic Air Conditioning System specified, any other items needed to make the system complete, safe and sound in operation shall be included under the scope of work by the Bidder at no extra cost to the Owner. The scope of supply shall not in any way be less than as indicated in schedule of supply. The various main equipment to be offered for the air conditioning system are indicated below:
1. Split air conditioners with wall mounted type IDU's of Owner Approved Manufacturers make with all accessories and as detailed in technical specification.
 2. Termination of drain piping to nearest drain point shall also be in Bidder's scope of work.
 3. All electrical work required for air conditioning system.
 4. Control & Instrumentation required for air conditioning system.
 5. All steel / cast iron inserts, plates, bolts, nuts, sleeves, metallic-fasteners etc. to be grouted in concrete work and used to hold/support the equipment/piping / being supplied and erected under this specifications.
 6. All the Equipments shall be protected against external corrosion by providing suitable painting.
 7. All ODU"s shall be provided a shed to protect from direct exposure of sunlight. If units are placed at Terrace then proper stand shall be provided.
- 9.02.00** **CIVIL WORKS**
- a. Civil works related to foundation/supporting arrangement of all final finishing of foundations and equipments. Grouting, dressing, opening in slabs /wall, etc. are also included in Bidders scope of work.
 - b. Repairing and making good/ sealing of cutouts / openings in floors ,roofs and walls provided by the bidder, for executing the works under this package and making them water tight as directed by the engineer in charge. c) Bidder's scope also includes supplying and laying of all anchor bolts, bed and foundation plates, sleeves, pipes, nuts and inserts including embedding in concrete/masonry for the equipment and piping to be supplied by the Bidder.
 - c. Providing inserts/ dash fasteners for supporting the equipment, ducts, pipes, etc. are in bidder's scope.
 - d. Providing necessary piping for carrying drain from Indoor Cooling Units to the nearest toilet / suitable location.
- 9.02.01** **BIDDER'S RESPONSIBILITIES**

TECHNICAL SPECIFICATIONS

- 9.02.01.01 The bidder's responsibilities include but not necessarily limited to the following items:
- 9.02.01.02 The bidder shall provide and install all supplementary parts necessary to complete all items generally implied in the drawings and in the specifications though not specifically shown or mentioned. The Work to be carried out under this work order comprises of Proprietary Design, Supply, Installation, Guarantees, Testing and Maintenance up to Defects Liability Period of the system for the entire building as per the specifications and parameters framed herewith. The Bidder shall carry out and complete the said work under this contract in every respect in conformity with the current standards and codes as per Bureau of Indian Standards / other relevant standards, and with the directions of and to the satisfaction of the Consultants and Employer.
- 9.02.01.03 Design Responsibility and Execution Responsibility Drawings and specifications indicate the required basic design intent and general performance criteria. The bidder shall have the option of modification and addition of details provided the over-all concept and performance requirements are fulfilled without commercial implication and the scheme should be approved by the consultant and employer before the modification work is carried out. Proposed modifications shall be clearly shown on the shop drawings as "Design Modifications" and acceptance of the same will not relieve the bidder from sole responsibility for performance of the systems shown on the Schedule or described herein, properly connected and in working condition. The Bidder shall be solely and fully responsible for due performance of his installation based on his own design and details. Checking from Consultants side will be only for general conformance to normal operation.
- 9.02.01.03 Fees, Permits and Tests The Bidder shall obtain and pay for any fees and permits required for the installation of the work. The Consultants / Owner shall have the right to test the materials or work to be tested QA to check by an independent agency at the Bidder's expense in order to prove their soundness and adequacy.
- 9.02.01.04 In-Plant and Job site inspection
- 9.02.01.05 The bidder shall afford the Employer, Engineer-in-Charge or their authorized agent full access to plants, shops and assembly points to replace view and inspect the processes and methods employed in the fabrication, assembly and finishing of the system works for this project.
- 9.02.01.06 The Engineer-in-Charge will have the right to reject any and all components and assemblies during assembly and erection if the

TECHNICAL SPECIFICATIONS

workmanship and intent are not in strict conformity with the approved shop drawings, design calculations, documentation, certifications and samples.

9.03.00 DESIGN CALCULATIONS

9.03.01 The Bidder shall employ a competent Design Engineer to design his systems and components. The bidder shall take full account of all possible adverse conditions in the design. The bidder shall submit his detailed design calculations for the systems and each of their components and shall guarantee that his design will ensure the safety and integrity of overall system.

9.03.02 The Bidder shall obtain Engineer-in-Charge approval to his design calculations and to the provisions made in his design for all adverse conditions. The Bidder alone shall be responsible for workmanship of fabrication and installation and shall indemnify the Employer against all claims due to defects or non-performance during the specified Guarantee period. The provisions of this clause shall not in any way limit the employer's rights under other clauses of the Contract.

9.03.03 Approved design calculations shall be submitted to Engineer-in-Charge.

9.04.00 GUARANTEE AND OPERATION ACCEPTANCE

9.04.01 The Bidder shall guarantee that, upon completion of work, all portions thereof will be in full accordance with the requirements of the specification and will be perfect as to the material and workmanship. The Bidder shall also guarantee that the equipment shall operate satisfactorily and the performance and efficiencies of the equipment when operating under normal conditions shall also be satisfactory. The Bidder shall further guarantee that during the period of one year from the date of final acceptance by the Owner, he will repair all defective works and will replace all defective materials furnished, free of cost to the Owner. The guarantee for replaced or repaired work shall be one year from the date of installation and acceptance of replaced/repaired parts.

9.04.02 Technical datasheet along with catalogue/ calculation/ document shall be submitted for approval.

9.05.00 CODES & STANDARDS

9.05.01 The design, manufacture and performance of equipment shall comply with all currently applicable statues, regulations and safety codes in the locality where the equipment are to be installed. Nothing in this specification shall be considered to relieve the bidder of his responsibility.

TECHNICAL SPECIFICATIONS

9.05.02 Unless otherwise specified, equipment shall conform to the latest applicable Indian or IEC standard or BEE standard. Equipment complying with other authoritative standards such as British, USA, ASHRAE, etc. will also be considered if it ensures performance equivalent or superior to Indian Standard.

9.05.03 All efforts have been made to provide as much information available for the existing facilities. However, bidder is advised to visit the site in order to acquaint himself with the present facilities and any other data that may be required for the purpose of bidding. Ignorance of site conditions and any data shall not be accepted as a basis of claims of any compensation whatsoever in future.

9.06.00 Technical Requirements : Air Conditioning System

9.06.01 Air Cooled Hi Wall split type Air conditioners of **5 Star BEE rating (Inverter Type - Cooling only)** shall be complete with Indoor unit(IDU), Out door unit (ODU), surface / concealed copper Refrigerant piping with insulation (closed cell elastomeric nitrile rubber tubular pipe section) upto 3 Mtr (IDU to ODU), copper power cable upto 3.5 Mtr (IDU to ODU) i/c drain pipe R-32/R-410/ R-407 Green Refrigerant, wireless Remote control, suitable for working between 180-260V with low & high voltage cutoff and 50 hz , 1 phase AC supply capable of performing cooling, dehumidification, air circulation of required capacity with Scroll / rotary compressor. The system shall be able to deliver 100% of the rated capacity upto 42 Degree Celsius. Min 5 year Original Equipment Manufacturer (OEM) warranty both compressor and Printed Circuit Board (PCB). Must comply : Electrical cable IS 694 or IS 9968 temperature sensing control IS /International Electro technical Commission (IEC) 60730, hermetic compressor IS 10617, heat exchanger IS 11329, capacitor IS 2993 and motor IS 12615. Complete as per CPWD specification and IS : 1391 Part II 2023. The system shall be able to operate up to 50 degC (out door ambient temperature).

9.06.02 All air conditioned areas shall be maintained at 24 deg. C \pm (plus or minus) 1 deg.

9.08.00 Description of Air Conditioning System scheme

9.08.01 For serving air-conditioning requirement of facilities at PRE-ENGINEERED ACCOMMODATION) of GNI PROJECT Township, **BEE – 5 Star rated inverter based** split air conditioners with wall mounted type IDU's have been envisaged.

9.09.00 SCHEDULE OF SUPPLY

TECHNICAL SPECIFICATIONS

Area to be air conditioned in Pre engineered Accommodations shall be as under

1. **Single Room Accommodation : Bedroom – 16 Nos - 1.5 TR**
2. **Suite Accommodation : Bedroom + Living Room – 6x2=12 Nos- 1.5 TR**
3. **Required no of Air conditioners for Dining and other common recreational areas to maintain the specified indoor condition.**

9.10.00 TECHNICAL INFORMATION AND DATA TO BE SUBMITTED ALONG WITH THE PROPOSAL

A) AIR CONDITIONING SYSTEM- 1.5 TR (BEE-5 Star) Inverter Split AC with wall mounted type IDU.

1. Model No.
2. Make
3. Rated Cooling Capacity (BTU/HR)
4. Numbers offered
5. Electric Rating Rated power Supply (Volt/ Phase/Hz)
6. EER(BTU/HR/W)
7. Operation Manual/remote
8. Power consumption at rated capacity (Total in KW)
9. Technical literatures of split air conditioners are enclosed?- Yes/No

NOTE: 1. Catalogue/ Literature regarding Technical specifications should be enclosed by the bidder with offer.

2. **Supply to be started only after instruction of EIC.**

3. Rating of split air conditioners shall be accepted as per the cooling capacity described for domestic market and Capacity rating test conditions under clause 8.1 of IS:1391 Part-2:1992. Acceptable tolerance level shall be as described under clause 9.9.5 of the same IS.

TECHNICAL SPECIFICATIONS

10.01.00 Submissions

- 10.01.01 The scheme drawings shall be provided by owner with tender. The development of detailed drawings, on the basis of tender drawings shall be in the scope of the bidder.
- 10.01.02 Detailed and co-ordinated architectural plans, elevations and sections incorporating structural details (GFC) shall be developed by the bidder.
- 10.01.03 Miscellaneous Architectural detail such as Finishing schedule, door window details, toilet details, flooring details, staircase detail, sanitary fixture details , balcony and railing details and other similar details shall developed by the bidder as per the tender drawings or as approved by Engineer-in -charge.
- 10.01.04 The structural analysis & design for superstructure shall be carried out using 3D modelling and STAAD/Equivalent software based on the tender drawings.
- 10.01.05 Design basis report shall be prepared covering all aspects of designs, parameters, assumptions, references, structural idealization/mathematical model, loading cases, load combinations, basis of analysis and clearance obtained from owner before commencement of detailed engineering.
- 10.01.06 The bidder shall be responsible for collection of all necessary data, norms, etc. from owner and other sources, as needed for satisfactory completion of work and ensuring all safety and stability of facilities.
- 10.01.07 The detailed structural design and drawings including foundation support system shall be duly vetted by NIT/IIT. Stability reports shall also be duly examined and issued by NIT/IIT. The duly vetted design, drawings and stability reports shall be submitted to owner and clearance obtained before commencement of work at site.
- 10.01.08 Detailed electrical drawings shall be submitted by bidder.
- 10.01.09 Shop drawings for door-windows, plumbing system, electrical conduits, fire detection and protection system, air- conditioning etc. or as mentioned in the specifications or as desired by engineer in charge, as per tender drawings or detailed working drawings issued by the owner shall be submitted.
- 10.01.10 All fabrication drawings shall be developed by the bidder.

TECHNICAL SPECIFICATIONS

- 10.01.11 All plumbing drawings including internal water supply, drainage, sewerage network, connecting to the external source/ destination shall be developed by the bidder.
- 10.01.12 All mechanical shop drawings, details including data sheets shall be submitted by the bidder. The drawings shall include Firefighting layout and scheme for each building, Fire detection and alarm system layout and scheme for each building, Air conditioning layout and scheme, any other drawing necessary for execution of the contract.
- 10.01.13 Any other coordinated drawings/ details desired by the owner for the satisfactory completion and commissioning of the Pre-engineered facility shall be developed and submitted by the bidder.
- 10.01.14 As-built drawings with quantities of various items of work building wise, structure wise, etc. duly certified by Engineer after execution of work shall be submitted by the bidder for information/record.
- 10.01.15 Bidder shall submit master list of drawings and documents as per the format approved by the owner.
- 10.01.16 Bidder shall submit all documents and drawings as per the following:
- Drawings – All GFC drawings prepared in the latest version of Auto CAD compatible with latest version of windows in soft copies via e-mail.
–2nos Hard copies of each approved GFC/construction drawing shall be submitted to owners site office
 - As Built Drawings: - In CD.
 - Design/Document - Soft copy via e-mail and two set of hard copies.

Other Notes:

- Commencement of construction, fabrication and erection shall be done after approval of the relevant documents and drawings.
- All GFC drawings shall be made in the Scale 1:50 for plans, Elevation & Sections and 1:20 & 1:10 for Construction Details
- All drawings shall be of standard sizes (Metric System) and shall be made on latest version of Auto CAD compatible with latest version of windows.
- All documents shall be made using MS Office.



TECHNICAL SPECIFICATIONS

11.00.00 LIST OF TENDER DRAWINGS

SI. No	DRAWING NO.	REV NO.	TITLE
	PRE-ENGINEERED ACCOMODATION		
1	8031-500-TOA-A-101	RA	GROUND FLOOR PLAN
2	8031-500-TOA-A-102	RA	FIRST FLOOR PLAN
3	8031-500-TOA-A-103	RA	ELEVATIONS & SECTIONS




SIDE



GROUND FLOOR PLAN

RA	RELEASED FOR TENDER PURPOSE ONLY.		SUPARNA						ANL	30.01.2025
REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD	MECH.	ELECT.	CIVIL	C & I	APPD	DATE
					CLEARED BY					

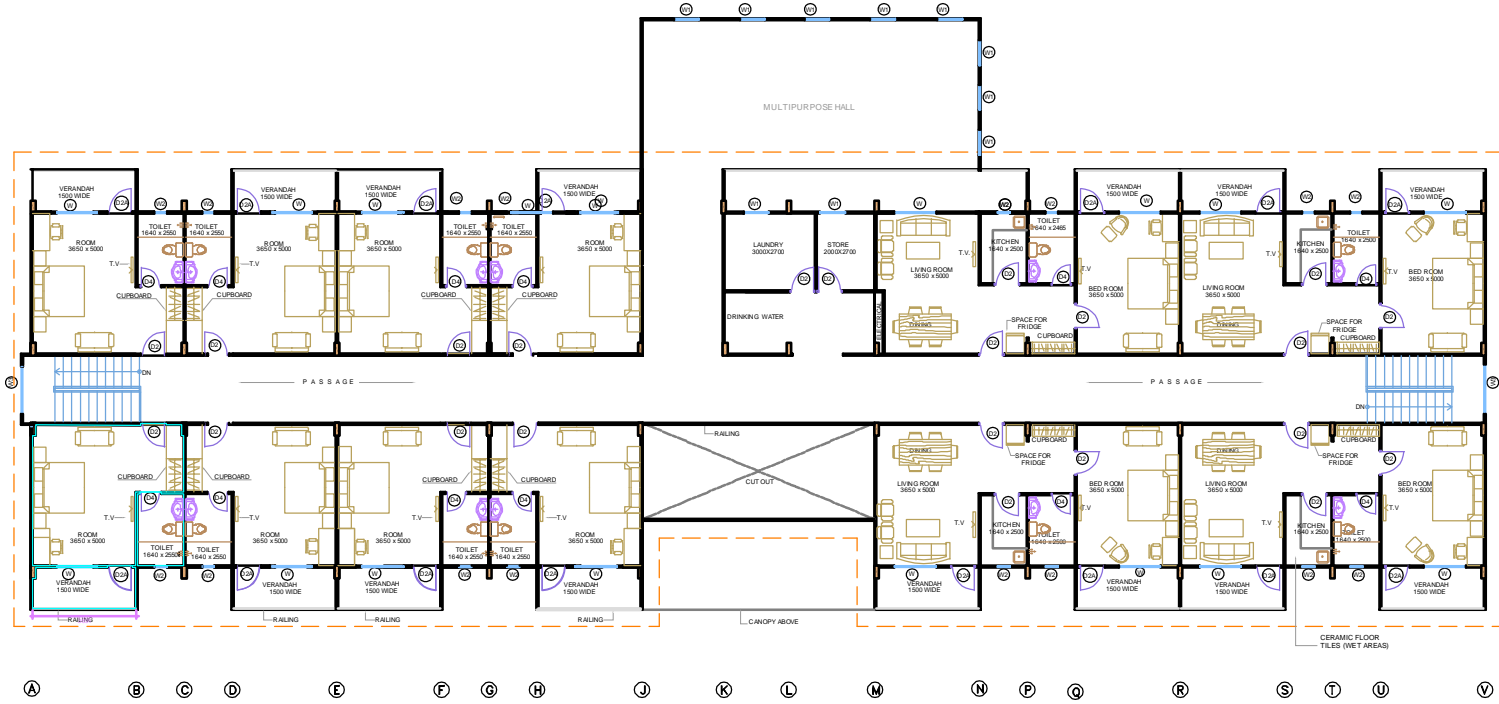
WINDOW SCHEDULE					
TYPE	MARK	WIDTH	HEIGHT	SILL LEVEL	TOP LEVEL
ANODISED ALUMINIUM GLAZED WINDOW AS/SPCC	W	1500	1200	500	2100
	W1	900	1200	500	2100
	W2	600	900	1200	2100
	W3	1350	2550	100	2550

		<p align="center">एन टी सी लिमिटेड POWER SUPPLY OF NTPC Limited <i>(A Star of India Company)</i></p>	
i j : k t u k PROJECT		जीएनआई गैस इंजन पावर प्रोजेक्ट चरण-1 (108 MW) GNI GAS ENGINE POWER PROJECT PHASE-I (108 MW)	
TITLE		BACHELOR & SUITE ACCOMMODATION PRE ENGINEERED STRUCTURE GROUND FLOOR PLAN	
SIZE	SCALE	DRG. NO.	REV. NO.
A1	1:100	8031-500-TOA-A-101	RA

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SIDE



FRONT

FIRST FLOOR PLAN

DOOR SCHEDULE

TYPE	MARK	WIDTH	HEIGHT	TOP LEVEL
ANODISED ALUMINIUM GLAZED DOOR AS/SPEC.	D1	1800	2550	2550
	D2	900	2100	2100
FLUSH DOOR AS/SPEC.	D3A	900	2100	2100
	D4	750	2100	2100
	D5	750	2100	2100

WINDOW SCHEDULE

TYPE	MARK	WIDTH	HEIGHT	BILL LEVEL	TOP LEVEL
ANODISED ALUMINIUM GLAZED WINDOW AS/SPEC.	W	1500	1200	900	2100
	W1	900	1200	900	2100
	W2	800	900	1200	2100
	W3	1350	2550	100	2550

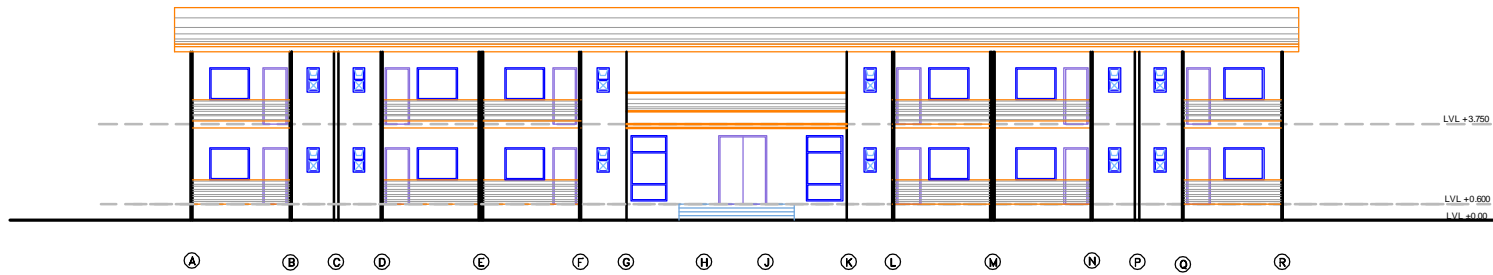


PROJECT: जीएनआई गैस इंजन पावर प्रोजेक्ट चरण-1
(108 MW)
GNI GAS ENGINE POWER PROJECT PHASE-1
(108 MW)

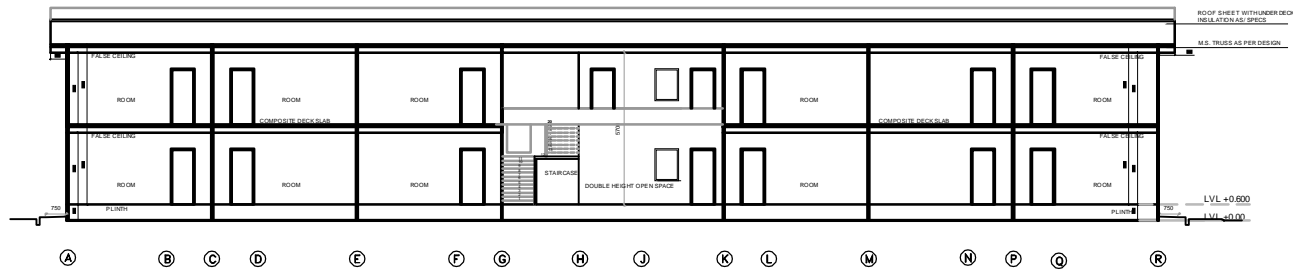
TITLE: BACHELOR & SUITE ACCOMMODATION
PRE ENGINEERED STRUCTURE
FIRST FLOOR PLAN

RA	REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	MECH.	ELECT.	CIVIL	C & I	ANL.	APPRO.	DATE	SIZE	SCALE	DRG. NO.	REV. NO.
													A1	1:100	8031-500-TOA-A-102	RA

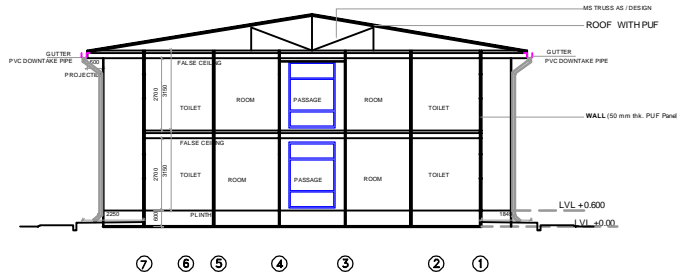
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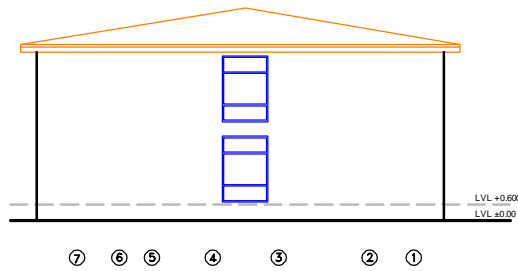
FRONT ELEVATION



SCHEMATIC SECTION 1-1



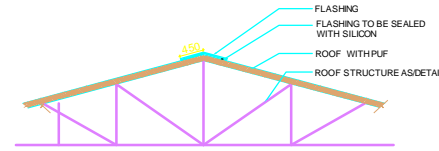
SCHEMATIC SECTION 2-2



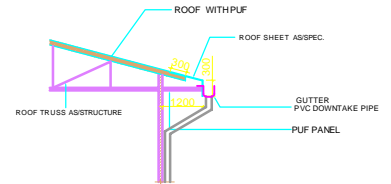
SIDE ELEVATION



KEY PLAN



TYPICAL ROOF RIDGE DETAIL



TYPICAL ROOF EDGE DETAIL

NOTES:-

1. ALL THE DIMENSIONS ARE IN MM & LVL ARE IN METERS.
2. DRAWING SHALL NOT BE SCALED ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.
3. ANY ERROR OR DISCREPANCY IN THE DRAWING IS TO BE BROUGHT TO THE NOTICE OF ENGINEER-IN-CHARGE.
4. THIS DRAWING SHALL BE READ ALONG WITH RESPECTIVE STRUCTURAL DRAWINGS AND OTHER DETAIL ARCHITECTURAL DRAWINGS.
5. THIS DRAWING SHALL NOT BE USED OTHER THAN THE PURPOSES MARKED ISSUED.

SCHEDULE OF DOORS & WINDOWS			
S.No.	SIZE	SILL LVL	DESCRIPTION
D1	1800 x 2550	-	AL. GLAZED DOOR
D2	900 x 2100	-	AL. FRAMED SOLID FLUSH DOOR
D2A	900 x 2100	-	AL. FRAMED SOLID FLUSH DOOR
D4	750 x 2100	-	AL. FRAMED SOLID FLUSH DOOR
W	1350 x 1200	900	AL. FRAMED SLIDING WINDOW
W1	900 x 1200	900	AL. FRAMED SLIDING WINDOW
W2	450 x 900	1200	AL. FIX LOUVERED VENTILATOR
W3	1350 x 2550	100	AL. FRAMED SLIDING WINDOW

RA	RELEASED FOR TENDER PURPOSE ONLY.				SUPARNA	CHKD.	MECH.	ELECT.	CIVIL	C & I	ANIL	APPD	DATE
REV.NO.	DESCRIPTION				DRAWN	DESIGN	CLEARED BY						

NTPC		NTPC Limited	
PROJECT		BACHELOR & SUITE ACCOMMODATION PRE ENGINEERED STRUCTURE ELEVATIONS	
SIZE		SCALE	
A1		1:100	
DRG. NO.		REV. NO.	
8031-500-TOA-A-103		RA	


D-1-9
ANNEXURES

D-1-9

ANNEXURE-I

GEO-TECH DATA AND FOUNDATION SYSTEM

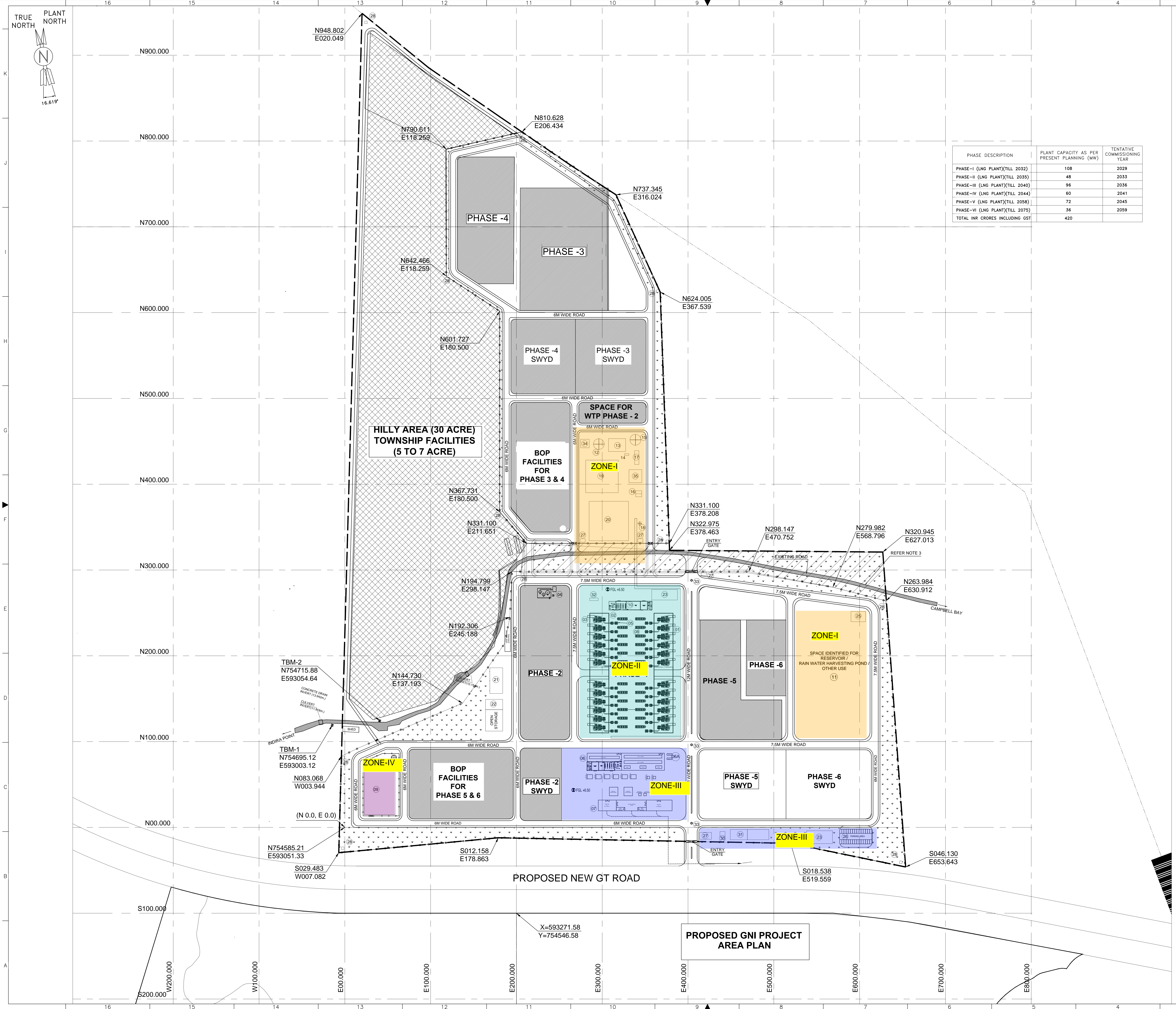
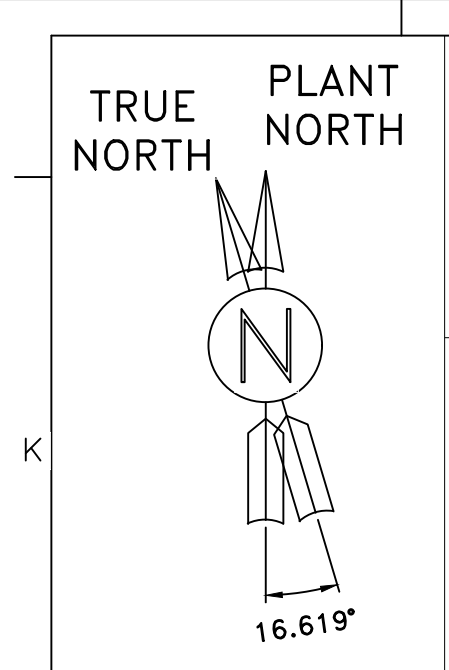
CLAUSE NO.	TECHNICAL REQUIREMENTS				<div>एनटीपीसी NTPC</div>																																																				
	<div>Annexure-I</div> <p>Employer has carried out geotechnical investigations in the proposed area. Logs of boreholes of proposed area are enclosed at Annexure-II.</p> <p>Based upon the available soil data, soil up to a depth of 5.0m below existing ground level is prone to liquefaction hazard. To eliminate the need for stone columns, the foundation depth has been recommended beyond the liquefiable zone.</p> <p>a) The minimum founding level and the corresponding net allowable bearing pressure shall be as given in Table – 1 below</p> <table><tr><th rowspan="3">Area</th><th rowspan="3">Founding RL</th><th colspan="3">Net Allowable Bearing Pressure T/m2</th></tr><tr><th colspan="2">Isolated and combined footings</th><th rowspan="2">Rafts (width > 6m)</th></tr><tr><th>Width upto 3.0m</th><th>Width > 3.0m upto 6m</th></tr><tr><td rowspan="2">Construction Store, WTP area, Construction office, Rain water Harvesting area (ZONE-I)</td><td>6.0m below FGL</td><td>22</td><td>24</td><td>25</td></tr><tr><td>7.0m below FGL</td><td>25</td><td>26</td><td>28</td></tr><tr><td rowspan="2">Engine Hall area (ZONE-II)</td><td>4.0m below FGL</td><td>15</td><td>15</td><td>19</td></tr><tr><td>5.0m below FGL</td><td>25</td><td>25</td><td>30</td></tr><tr><td rowspan="2">Switchyard area, Admin bldg., Security office, Safety center, safety park, (ZONE-III)</td><td>3.0m below FGL</td><td>10</td><td>11</td><td>15</td></tr><tr><td>4.0m below FGL</td><td>15</td><td>15</td><td>18</td></tr><tr><td rowspan="2">Gas metering station, enabling township (ZONE-IV)</td><td>1.0m below FGL</td><td>10</td><td>11</td><td>15</td></tr><tr><td>2.0m below FGL</td><td>15</td><td>15</td><td>18</td></tr></table> <p>For Finished ground level (FGL) refer General layout plan (GLP)</p> <p>In case any loose/soft pockets is encountered at founding level, the same shall be removed completely upto the hard strata and filled up with PCC M7.5.</p> <p>The net allowable bearing pressure higher than above mentioned values shall not be permitted. At intermediate levels the bearing capacity shall be same as the net allowable bearing pressure corresponding to the immediate shallower level mentioned above.</p> <p>For open foundations, the total permissible settlement shall be governed by IS: 1904 / IS: 13063 and from functional requirements whichever is more stringent. However, total settlement shall be restricted to the following:</p> <table><tr><td>Isolated & Strip</td><td>40 mm</td></tr><tr><td>Raft</td><td>75 mm</td></tr><tr><td>Foundations in Weathered rock / rock</td><td>12 mm</td></tr></table> <p>In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced after review in consultation with Engineer.</p>					Area	Founding RL	Net Allowable Bearing Pressure T/m2			Isolated and combined footings		Rafts (width > 6m)	Width upto 3.0m	Width > 3.0m upto 6m	Construction Store, WTP area, Construction office, Rain water Harvesting area (ZONE-I)	6.0m below FGL	22	24	25	7.0m below FGL	25	26	28	Engine Hall area (ZONE-II)	4.0m below FGL	15	15	19	5.0m below FGL	25	25	30	Switchyard area, Admin bldg., Security office, Safety center, safety park, (ZONE-III)	3.0m below FGL	10	11	15	4.0m below FGL	15	15	18	Gas metering station, enabling township (ZONE-IV)	1.0m below FGL	10	11	15	2.0m below FGL	15	15	18	Isolated & Strip	40 mm	Raft	75 mm	Foundations in Weathered rock / rock	12 mm
Area	Founding RL	Net Allowable Bearing Pressure T/m2																																																							
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GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART B BID DOC NO: CS-6401-001-2		Foundation & Geotechnical Data	Page 1 of 2																																																				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
b)	<p>Special Requirements:</p> <p>In view of the close proximity to sea, following shall be adopted for all foundations and sub-structures</p> <ul style="list-style-type: none"> - Minimum grade of concrete shall be M30. - Minimum cement content shall be 370 kg/m³ and maximum free water-cement ratio shall be 0.45 for foundation works. - Reinforcement steel (High Strength Deformed steel bars) shall be Corrosion Resistance thermo-mechanically treated (CRS-TMT) bars and shall confirm to grade Fe-500/500D/550D and shall confirm to IS:1786 and IS 13920 (with minimum percentage of elongation of 14.5%). - For foundations, the minimum cover to reinforcement shall be 60mm. - “Severe” exposure condition as per IS 456 to be considered for mix design. - All foundations and surfaces of substructures coming in contact with earth shall be applied with Minimum two coats of hot bitumen of Industrial grade 85/25, conforming to IS: 702 (latest), mixed with 1% anti-stripping compound at the rate 1.7 Kg/Sq.m (for sum of all coats). 			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART B BID DOC NO: CS-6401-001-2	Foundation & Geotechnical Data	Page 2 of 2	

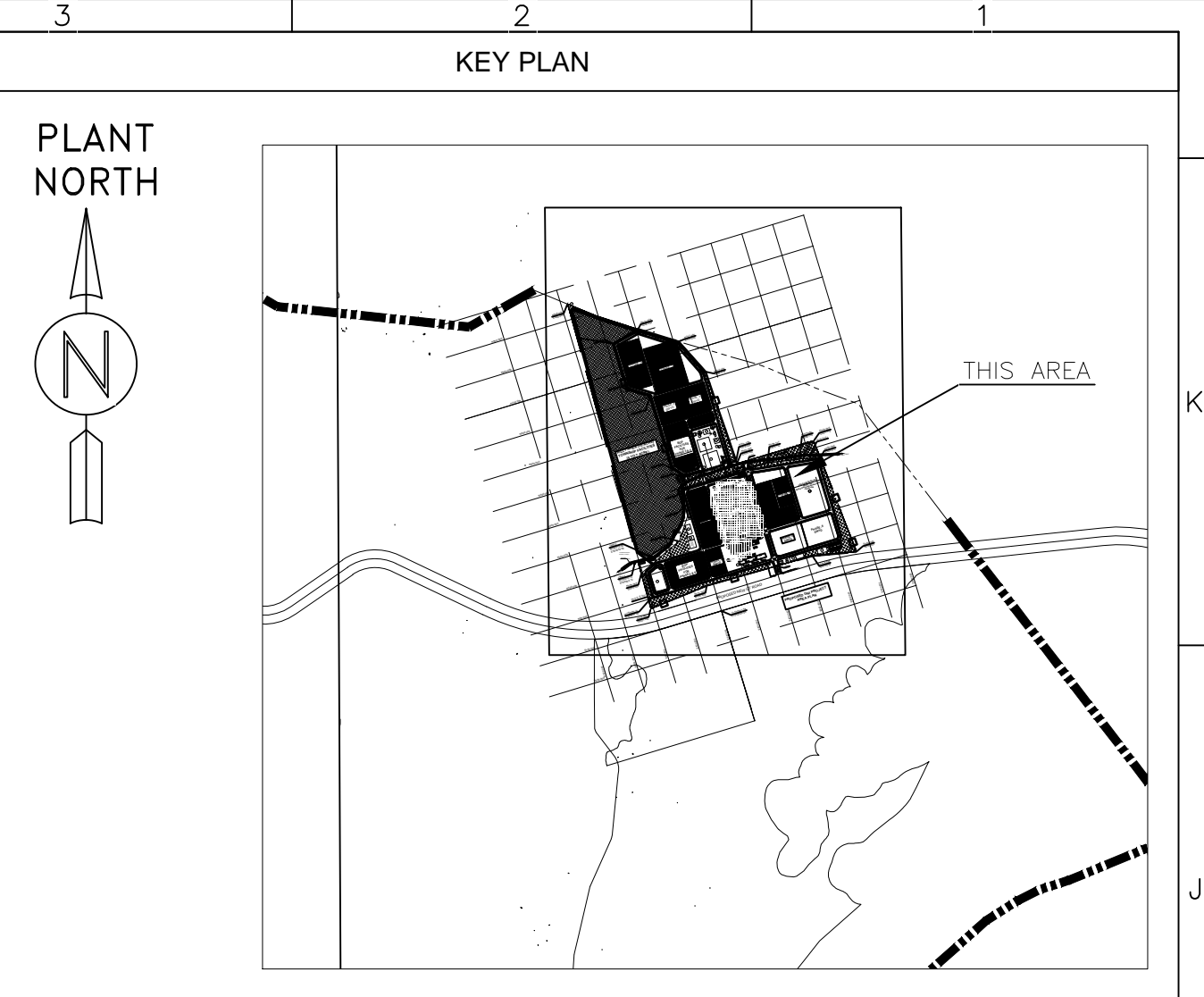
D-1-9

ANNEXURE-II

BORELOG LOCATIONS



PHASE DESCRIPTION	PLANT CAPACITY AS PER PRESENT PLANNING (MW)	TENTATIVE COMMISSIONING YEAR
PHASE-I (LNG PLANT)(TILL 2032)	108	2029
PHASE-II (LNG PLANT)(TILL 2035)	48	2033
PHASE-III (LNG PLANT)(TILL 2040)	96	2036
PHASE-IV (LNG PLANT)(TILL 2044)	60	2041
PHASE-V (LNG PLANT)(TILL 2058)	72	2045
PHASE-VI (LNG PLANT)(TILL 2075)	36	2059
TOTAL INR CRORES INCLUDING GST	420	



- GENERAL NOTES
1. ALL DIMENSIONS ARE IN mm.CO-ORDINATES AND GRID ARE IN METER.
 2. THE BUILDING SIZES ARE PRELIMINARY.
 3. EXISTING BLACK TOP ROAD SHOWN INSIDE THE PLANT BOUNDARY WILL BE MODIFIED ONCE PROPOSED NEW GT ROAD COMPLETED.

ITEM NO.	DESCRIPTION	BUILDING SIZE IN (M)	REMARKS
01	ENGINE & GENERATING SET (4.5MW x 24NOS)	140x22.5	
02	ENGINE AUXILIARY MODULE(EAM)	---	
03	INTAKE AIR FILTER	---	
04	LUBE OIL TANK AREA	16x12	
05	EXHAUST GAS SYSTEM	---	
06	MAIN ELECTRICAL, CONTROL & UPS BUILDING (11KV/415V SWGR BATTERY & DC CHARGER)	90x20	
06A	BLACK START DG	6x2	
07	132/33KV GIS & CONTROL ELECTRICAL BUILDING	86x12.5	
08	RADIATOR	10.44x3.01 (24x3)	
09	GAS METERING STATION	56x36	
10	AIR COMPRESSOR HOUSE (GROUND FLOOR) / CONTROL ROOM & UPS ROOM	17x15	
11	RESERVOIR	---	
12	RAW WATER TANK	#12.5	
13	SOFTENER PLANT	20x15	
14	NEUTRALISING PIT	5x2	
15	SOFTENER STORAGE TANK	#12.8	
16	SERVICE WATER CUM FIRE WATER TANK	7x7	
17	SERVICE WATER CUM FIRE WATER PUMP HOUSE	16x5	
18	POTABLE WATER TANK	#4	
19	CONSTRUCTION OFFICE	38x38	
20	CONSTRUCTION STORE	46x46	
21	PERMANENT STORE	30x15	
22	WAREHOUSE	20x12	
23	ADMIN BUILDING	29x29	
24	CANTEEN	20x12	
25	FIRE STATION	17x12	
26	CAR PARKING	---	
27	SECURITY OFFICE	6x4	
28	WATCH TOWER	3.3x3.3	
29	OILY WATER SEPARATOR	---	
30	SAFETY CENTRE	6x6	
31	SAFETY PARK & ASSEMBLE POINT	---	
32	INERT GAS FIRE EXTINGUISHING CYLINDER STORAGE ROOM	10x3	
33	LIGHTING MAST	---	
34	RAW WATER PUMP	10x10	
35	SWITCH GEAR & CONTROL ROOM FOR WTP	15x15	

TOTAL AREA 98.346 ACRES

GREEN BELT AREA 10.000 ACRES

LEGEND

- PIPE/CABLE RACK
- PLANT BOUNDARY
- TOTAL PLOT AREA
- FENCING
- ROAD
- TEMPORARY BENCHMARK

OPTION - 2

FOR DPR PURPOSE

EXHIBIT No.02

PROJECT: DPR FOR 108MW LNG based Gas Engine Power Project, Great Nicobar Island

OWNER: NTPC Limited (A Govt. of India Enterprise) (Formerly National Thermal Power Corporation Ltd.)

OWNER'S CONSULTANT: FICHTNER Consulting Engineers (India) Private Limited Chennai

REVISIONS:

REV.	DATE	DESCRIPTION	DRN.	APPROVED BY		
C	25.08.2025		SRM	GYN	VR	NC
B	06.08.2025		SRM	GYN	VR	NC
A	28.04.2025		SRM	GYN	VR	NC

DEPT. MECHANICAL JOB NO. 20124256 SCALE: 1:1000 REV.

PLOT PLAN

DWG.NO.

RELEASED

CONSTRUCTION

SHEET: 01 OF 01

D-1-9

ANNEXURE-A

LIST OF CODES AND STANDARDS

CLAUSE NO.	TECHNICAL REQUIREMENTS		
D-1-12 D-1-12(A)	<div>ANNEXURES</div> <div>ANNEXURE (A)</div> <div>(a) List of Codes and Standards</div> <div>All applicable standards, references, specifications, codes of practice, etc., shall be the latest edition including all applicable official amendments and revisions. A complete set of all these documents shall be available at site with Bidder. List of some of the applicable Standards, in original Codes and references is as following:</div> <div>Where provisions are not covered in Indian Standards, reference shall be made to ACI, AISC, EN, CICIND and other International Standards.</div> <div><u>LIST OF CODES AND STANDARDS</u></div> <div>Excavation and Filling</div> <div>IS :2720 Methods of test for soils(relevant parts)</div> <div>IS:4701 Code of practice for earth work on canals.</div> <div>IS:9759 Guide lines for dewatering during construction.</div> <div>IS:10379 Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.</div> <div>Properties, Storage and Handling of Common Building Materials</div> <div>IS:269 33 grade for ordinary Portland cement.</div> <div>IS:383 Coarse and fine aggregates from natural sources for concrete.</div> <div>IS:432 Specification for mild steel and medium tensile steel bars and</div> <div>(Part 1&2) hard drawn steel wires for concrete reinforcement.</div> <div>IS:455 Portland slag cement.</div> <div>IS:702 Industrial bitumen.</div> <div>IS:712 Specification for building limes.</div> <div>IS:1077 Common burnt clay buidling bricks.</div> <div>IS:1161 Steel tubes for structural purposes.</div> <div>IS:1239 Mild steel tubes, tubulars and other wrought steel fillting - MS tubes.</div> <div>IS:1363 Hexagon head bolts, screws and nuts of productions</div> <div>(Part 1-3) grade - C.</div> <div>IS:1364 Hexagon head bolts, screws and nuts of productions</div> <div>(Part 1-5) grade-A & B.</div> <div>IS:1367 Technical supply condition for threaded fasteners.</div> <div>(Part 1-18)</div> <div>IS:1489 Portland-pozzolana cement.</div> <div>(Part-I) Fly ash based</div> <div>IS:1542 Sand for Plaster.</div>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2	SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS	PAGE 1 OF 16

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>IS:1566 Hard drawn steel wire fabric for concrete reinforcement.</p> <p>IS:1786 High strength deformed steel bars & wires for concrete reinforcement.</p> <p>IS:2062 Hot Rolled Low, Medium and High Tensile Structural Steel</p> <p>IS:2116 Sand for masonry mortars.</p> <p>IS : 2185 Hollow & solid concrete blocks. (Part 1) (Part 2) Hollow & solid light weight concrete blocks.</p> <p>IS:2386 Testing of aggregates for concrete. (Part I-VIII)</p> <p>IS:3812 Specification for fly ash for use as pozzolona and admixture.</p> <p>IS:4082 Recommendation on stacking and storage of construction materiel and components at site</p> <p>IS:8112 43 grade ordinary portland cement.</p> <p>IS:8500 Structural steel-Microalloyed (Medium and high strength qualities).</p> <p>IS:12269 53 grade ordinary portland cement.</p> <p>IS:12894 Specification for fly ash lime bricks.</p> <p>IS:13757 Burnt clay fly ash building bricks.</p> <p>Cast in-situ Concrete and Allied Works</p> <p>IS:280 Mild steel wire for general engineering purpose.</p> <p>IS:456 Code of practice for plain and reinforcement concrete.</p> <p>IS:457 Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.</p> <p>IS:516 Method of test for strength of concrete. IS:1199 Methods of sampling and analysis of concrete.</p> <p>IS:1791 General requirement for batch type concrete mixers.</p> <p>IS:1834 Hot applied sealing compound for joints in concrete. IS:1838 Preformed fillers for expansion joints in concrete pavement and structures.</p> <p>IS:2438 Specification for roller pan mixers.</p> <p>IS:2502 Code of practice for bending and fixing of bars for concrete reinforcement.</p> <p>IS:2505 Concrete vibrators - immersion type.</p>			
<p>GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE</p>		<p>TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2</p>	<p>SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS</p>	<p>PAGE 2 OF 16</p>

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<div>IS:2506General requirements for screed board concrete vibrators.</div> <div>IS:2722Specification for Portable Swing weigh batchers for concrete (single and double bucket type).</div> <div>IS:2750Steel scaffoldings</div> <div>IS:2751Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.</div> <div>IS:3150Hexagonal wire netting for general purposes.</div> <div>IS:3366Specification for pan vibrators.</div> <div>IS:3370 (Part 1-4)Code of practice for concrete structures for the storage of liquids.</div> <div>IS:3558Code of practice for use of immersion vibrators for consolidating concrete.</div> <div>IS:4014 (Part-1&2)Code of practice for steel tubular scaffolding.</div> <div>IS:4326Code of practice for earth quake resistant design and construction of buildings.</div> <div>IS:4656Form vibrators for concrete.</div> <div>IS:4925Concrete batching and mixing plant.</div> <div>IS:4990Plywood for concrete shuttering work.</div> <div>IS:4995Criteria for design of reinforced concrete bins for storage of granular and powdery materials</div> <div>IS:5256Code of practice for sealing expansion joints in concrete lining on canals.</div> <div>IS:5525Recommendations for detailing of reinforcement in reinforced concrete works.</div> <div>IS:6461Glossary of terms relating to cement concrete.</div> <div>IS:6494Code of practice for water proofing of underground reservoir and swimming pools.</div> <div>IS:6509Code of practice for installation of joints in concrete pavements.</div> <div>IS:7861 (Part -1&2)Code of practice for extreme weather concreting.</div> <div>IS:9012Recommended practice for shotcreting.</div> <div>IS:9103Admixtures for concrete.</div> <div>IS:9417Recommendations for welding cold worked bars for reinforced concrete construction.</div> <div>IS:10262Recommended guidelines for concrete mix design.</div> <div>IS:11384Code of practice for composite construction in structural steel and concrete.</div>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2	SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS	PAGE 3 OF 16

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<div>IS:12118Two parts polysulphide based sealants.</div> <div>IS:12200Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams.</div> <div>IS:13311Non destructive testing of concrete - methods of test.</div> <div>(Part 1)Ultrasonic pulse velocity.</div> <div>(Part 2)Rebound hammer.</div> <div>IS:17452Use of Alkali Activated Concrete for Precast Products-Guidelines</div> <div>SP-16Design codes for reinforced concrete to IS:456-1978.</div> <div>SP-23Hand book of concrete mixes.</div> <div>SP-24Explanatory handbook on Indian standards code for plain and reinforced concrete. (IS : 456)</div> <div>SP-34Hand book on concrete reinforcement and detailing.</div> <div>ACI-318American Concrete Institute code for structural concrete.</div> <div>Precast Concrete Works</div> <div>SP:7National Building Code - Structural Design</div> <div>(Part 6/Sec.7)Prefabrication and system building and mixed / composite construction.</div> <div>IS:10297Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.</div> <div>IS:10505Code of practice for construction of floors and roofs using pre-cast reinforced concrete waffle units.</div> <div>IS:15658Pre-cast concrete block for paving.</div> <div>IS 15916Building Design and Erection using Pre fabricated concrete</div> <div>Masonry & Allied Works</div> <div>IS:1905Code of practice for structural use of unreinforced masonry.</div> <div>IS: 2185Part-1 Concrete Masonry Units - Specification Part 1 Hollow and Solid Concrete Blocks</div> <div>Part-3 Specification for concrete masonry units: Part 2 Hollow and solid light weight concrete blocks</div> <div>IS:2212Code of practice for brick work.</div> <div>IS:2250Code of practice for preparation and use of masonry mortars.</div> <div>IS:2572Code of practice for construction of hollow concrete block masonry.</div> <div>SP:20Hand book on masonry design and construction.</div>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2	SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS	PAGE 4 OF 16

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>Sheeting Works</p> <p>IS:277 Galvanised steel sheets (Plan & corrugated).</p> <p>IS:513 Cold-rolled low carbon steel sheets & strips.</p> <p>IS:730 Hook bolts for corrugated sheet roofing.</p> <p>IS:801 Code of practice for use of cold formed light gauge steel structural members in general building construction.</p> <p>IS:2527 Code of practice for fixing rain water gutters and down pipe for roof drainage.</p> <p>IS:7178 Technical supply condition for tapping screw.</p> <p>IS:8183 Bonded mineral wool.</p> <p>IS:8869 Washers for corrugated sheet roofing.</p> <p>IS:12093 Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.</p> <p>IS:12436 Preformed rigid Polyurethane (PUR) and isocyanurate (PIR) foams for thermal insulation.</p> <p>IS:12866 Plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced).</p> <p>IS:14246 Continuously pre-painted galvanised steel sheets and coils.</p> <p>BS:5950 Code of practice for design of light gauge profiled (Part-6) steel sheeting</p> <p>Fabrication and Erection of Structural Steel Works</p> <p>IS:800 Code of practice for General Construction of steel.</p> <p>IS:808 Hot rolled Steel Beam, Column, Channel and Angel Sections.</p> <p>IS:813 Scheme for symbols for welding.</p> <p>IS:814 Covered electrodes for manual metal arc welding of carbon & carbon manganese steel.</p> <p>IS:816 Code of practice for use of metal arc welding for general construction in mild steel.</p> <p>IS:817 Code of practice for training and testing of metal arc welders.</p> <p>IS:1024 Welding in bridges and substructured subject to dynamic.</p> <p>IS:1181 Qualifying tests for Metal Arc welders (engaged in welding structures other than pipes).</p>			
<p>GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE</p>		<p>TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2</p>		<p>SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS</p>
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	IS:1182	Recommended practice for Radiographic examination of fusion welded butt joints in steel plates		
	IS:1608	Mechanical testing of metals - tensile testing		
	IS:1852	Rolling and Cutting Tolerances for Hot rolled steel products.		
	IS:2016	Specification for Plain washers.		
	IS:2595	Code of practice for Radiographic testing		
	IS:2629	Hot dip galvanising of iron and steel		
	IS:3502	Steel chequered plate.		
	IS:3613	Acceptance tests for wire flux combination for submerged arc welding.		
	IS:3658	Code of practice for liquid penetrant flaw detection.		
	IS:3664	Code of practice for ultra sonic pulse echo testing contact and immersion method		
	IS:3757	High strength structural bolts.		
	IS:4000	High strength bolts in steel structure - code of practice.		
	IS:4353	Sub merged arc welding of mild steel and low alloy steel Recommendation		
	IS:4759	Hot dip zinc coating on structural steel and other allied products.		
	IS:5334	Code of practice for magnetic particle flaw detection of welds.		
	IS:5369	General requirements for plain washers and lock washer		
	IS : 6623	High strength structural nuts.		
	IS:6649	Hardened and tampered washers for high strength structural bolts & nuts.		
	IS:6911	Stainless steel plate, sheet and strip.		
	IS:7205	Safety code for erection of structural steel.		
	IS:7215	Tolerances for fabrication of structural steel.		
	IS:7307	Approved test for welding procedures		
	(Part - I)	Fusion welding of steel.		
	IS:7310 (Part-I)	Approval test for welders working to approval welding procedure. Fusion welding of steel		
	IS:9178 (Part-1to 3)	Criteria for design of steel bins for storage of bulk material.		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2	SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS	PAGE 6 OF 16

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<div>IS:9595Recommendations for metal arc welding of carbon & carbon manganese steel.</div> <div>IS:12843Tolerances for erection of steel structures.</div> <div>SP:6 (Part 1 to 7)ISI Hand book for structural Engineers.</div> <div>Plastering and Allied Works</div> <div>IS:1661Code of practice for application of cement and cement lime plaster finishes.</div> <div>IS:2402Code of practice for external rendered finishes.</div> <div>IS:2547 (Parts 1&2)Gypsum building plaster.</div> <div>Acid and Alkali Resistant Lining</div> <div>IS:158Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.</div> <div>IS:412Expanded metal steel sheets for general purpose.</div> <div>IS:4441Code of practice for use of silica type chemical resistant mortars.</div> <div>IS:4443Code of practice for use of resin type chemical resistant mortars.</div> <div>IS:4456 (Part I & II)Method of Test for chemical resistant tiles.</div> <div>IS:4457Ceramic unglazed vitreous acid resisting tiles.</div> <div>IS:4832Specification for chemical resistant mortars.</div> <div>(Part - 1)Silicate type</div> <div>(Part - 2)Resin type</div> <div>(Part - 3)Sulfur type</div> <div>IS:4860Acid resistant bricks.</div> <div>IS:9510Bitumastic acid resisting grade.</div> <div>Water Supply, Drainage and Sanitation</div> <div>IS:458Precast concrete pipes (with & without reinforcement).</div> <div>IS:554Pipe threads where pressure tight joints are made on the threads – dimensions, tolerances and designation.</div> <div>IS:651Salt glazed stoneware pipes and fittings.</div> <div>IS:774Flushing cisterns for water closets and urinals.</div>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2	SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS	PAGE 7 OF 16

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>IS:775 Cast iron brackets and supports for wash basins and sinks.</p> <p>IS:778 Copper alloy gate, globe and check valves for water works purposes.</p> <p>IS:781 Cast copper alloy screw down bib taps & stop valves for water services.</p> <p>IS:782 Caulking lead.</p> <p>IS:783 Code of practice for laying of concrete pipes.</p> <p>IS:1172 Code of basic requirements of water supply, drainage and sanitation.</p> <p>IS:1230 Cast iron rain water pipes and fittings.</p> <p>IS:1239 Mild Steel tubes, tubulars and other wrought steel fittings (Part 1&2)</p> <p>IS:1536 Centrifugally cast (Spun) iron pressure pipes for water.</p> <p>IS:1537 Vertically cast iron pressure pipes for water, gas and sewage.</p> <p>IS:1538 Cast iron fittings for pressure pipe for water, gas and sewage.</p> <p>IS:1703 Copper alloy float valve for water supply fitting.</p> <p>IS:1726 Cast iron manhole covers and frames.</p> <p>IS:1729 Cast iron / Ductile iron drainage pipes and pipe/fittings for over ground non pressure pipeline socket and spigot series.</p> <p>IS:1742 Code of practice for building drainage.</p> <p>IS:2064 Selection, installation and maintenance of sanitary appliances.</p> <p>IS:2065 Code of practice for water supply in buildings.</p> <p>IS:2326 Automatic flushing cisterns for urinals.</p> <p>IS:2548 Plastic seats and covers for water closets.</p> <p>IS:2556 Vitreous sanitary appliances (vitreous china).</p> <p>IS:3114 Code of practice for laying of cast iron pipes.</p> <p>IS:3311 Waste plug and its accessories for sinks and wash basins.</p> <p>IS:3438 Silvered glass mirrors for general purposes.</p> <p>IS:3486 Cast iron spigot and socket drain pipes.</p> <p>IS:3589 steel pipe for water and sewage (168.3 to 2540mm outside diameter)</p> <p>IS:3989 Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.</p> <p>IS:4111 Code of practice for ancillary structure in sewerage system.</p>			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2	SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS	PAGE 8 OF 16

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>(Part 1 to 5)</p> <p>IS:4127 Code of practice for laying of glazed stone ware pipes.</p> <p>IS : 4733 Methods of sampling and testing sewage effluents.</p> <p>IS:4764 Tolerance limits for sewage effluents discharged into inland surface waters.</p> <p>IS:1068 Electroplated coating of nickel plus chromium and copper plus nickel plus chromium.</p> <p>IS:5329 Code of practice for sanitary pipe work above ground for buildings.</p> <p>IS:5382 Rubber sealing rings for gas mains, water mains and sewers.</p> <p>IS:5822 Code of practice for laying of electrically welded steel pipes for water supply.</p> <p>IS:5961 Specification for cast iron grating for drainage purpose.</p> <p>IS:7740 Code of practice for construction and maintenance of road gullies.</p> <p>IS:8931 Copper alloy fancy single taps combination tap assembly and stop valves for water services.</p> <p>IS:9762 Polyethylene floats for float valves.</p> <p>IS:10592 Industrial emergency showers, eye and face fountains and combination units.</p> <p>IS:12592 Specification for precast concrete manhole covers and frames.</p> <p>IS:12701 Rotational moulded polyethylene water storage tanks.</p> <p>IS:13983 Stainless steel sinks for domestic purposes.</p> <p>SP:35 Hand book on water supply and drainage with special emphasis on plumbing.</p> <p>CPH&EEO Manual on sewage and sewage treatment</p> <p>Publication - as updated.</p> <p>Doors Windows and Allied Works</p> <p>IS:204 Tower Bolts.</p> <p>(Part 1) Ferrous metals</p> <p>(Part 2) Non - ferrous metals</p> <p>IS:208 Door Handles.</p> <p>IS:281 Mild steel sliding door bolts for use with padlocks.</p> <p>IS:362 Parliament Hinges.</p> <p>IS:419 Putty, for use on window frames.</p>			
<p>GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE</p>		<p>TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2</p>	<p>SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS</p>	<p>PAGE 9 OF 16</p>

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>IS:451 Technical supply conditions for wood screws</p> <p>IS:733 Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes.</p> <p>IS:1003 Timber panelled and glazed shutters (doors shutters). (Part I)</p> <p>IS:1003 Timber panelled and glazed shutters (Part-1) door shutters.</p> <p>IS:1038 Steel doors, windows and ventilators.</p> <p>IS:1081 Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.</p> <p>IS:1285 Wrought aluminium and aluminium alloy extruded round tube & hollow section (for general engineering purposes).</p> <p>IS:1341 Steel butt hinges.</p> <p>IS:1361 Steel windows for Industrial buildings.</p> <p>IS:1823 Floor door stoppers.</p> <p>IS:1868 Anodic coatings on Aluminium and its alloys.</p> <p>IS:2202 Wooden flush door shutters (solid core type) particle (Part-2) board face panels and hard board face panels.</p> <p>IS:2209 Mortice locks (vertical type)</p> <p>IS:2553 Safety glass. (Part-1) General purposes</p> <p>IS:2835 Flat transparent sheet glass.</p> <p>IS:3548 Code of practice for glazing in buildings.</p> <p>IS:3564 Door closers (Hydraulically regulated)</p> <p>IS:3614 Specification for fire check doors : (Part-1) plate, metal covered and rolling type. (Part-2) Resistance test and performance criteria.</p> <p>IS:4351 Specification for steel door frames.</p> <p>IS:5187 Flush bolts.</p> <p>IS:5437 Figured, rolled and wired glass.</p>			
<p>GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE</p>		<p>TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2</p>	<p>SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS</p>	<p>PAGE 10 OF 16</p>

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<div>IS:6248 Specification for metal rolling shutters and rolling grills.</div> <div>IS:6315 Specification for floor springs (Hydraulically regulated) for heavy doors.</div> <div>IS:7196 Hold fast.</div> <div>IS:7452 Hot rolled steel sections for doors, windows and ventilators.</div> <div>IS:10019 Mild steel stays and fasteners.</div> <div>IS:10451 Steel sliding shutters (top hung type)</div> <div>IS:12823 Prelaminated particle boards.</div> <div>Roof Water Proofing and Allied Works</div> <div>IS:3067 code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.</div> <div>ASTM Standard specification for high solid content cold</div> <div>C836-89a liquid applied elastomeric water proofing membrane for use with separate wearing course.</div> <div>ASTM Standard guide for high solid content cold</div> <div>C898-89 liquid applied elastomeric water proofing membrane for use with separate wearing course.</div> <div>Floor Finishes and Allied Works</div> <div>IS:5318 Code of practice for laying of flexible PVC sheet and tile flooring.</div> <div>IS:8042 White portland cement.</div> <div>IS:13755 Dust pressed ceramic tiles with water absorption of 3%, E 6% (Group B11a).</div> <div>IS:13801 Chequered cement concrete tiles.</div> <div>Painting and Allied Works</div> <div>IS:162 Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as required.</div> <div>IS:428 Distemper, oil, emulsion, colour as required.</div> <div>IS:1477 Code of practice for painting of terrous metals in buildings.</div> <div>(Part -1) Pretreatment.</div> <div>(Part -2) Painting.</div> <div>IS:1650 Specification for colours for building and decorative materials.</div>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2	SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS	PAGE 11 OF 16

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>IS:2074 Ready mixed paint, air drying, red oxide-zinc chrome, priming.</p> <p>IS:2338 Code of practice for finishing of wood and wood based materials.</p> <p>(Part -1) Operations and Workmanship.</p> <p>(Part -2) Schedule.</p> <p>IS:2395 Code of practice for painting concrete, masonry and plaster surfaces.</p> <p>(Part-1) Operations and Workmanship.</p> <p>(Part -2) Schedule.</p> <p>IS:2524 Code of practice for painting of nonferrous metals in buildings.</p> <p>(Part -1) Pretreatment</p> <p>(Part -2) Painting.</p> <p>IS:2932 Enamel, synthetic, exterior, (a) under coating and (b) finishing.</p> <p>IS:2933 Enamel exterior, (a) under coating, (b) finishing.</p> <p>IS:4759 Hot dip zinc coatings on structural steel and other allied products.</p> <p>IS:5410 Specification for cement paint.</p> <p>IS:15489 Plastic emulsion paint.</p> <p>IS:6278 Code of practice for white washing and Colour washing.</p> <p>IS:10403 Glossary of term related to building finish.</p> <p>IS:12027 Silicone based water repellent</p> <p>IS:13238 Epoxy based zinc phosphate primer (2 pack)</p> <p>IS:13239 Epoxy surfacer (2 pack)</p> <p>IS:13467 Chlorinated rubber for paints</p> <p>IS:14209 Epoxy enamel, two component glossy.</p> <p>BS:5493 Code of practice for protective coating of iron and steel structures against corrosion.</p> <p>Piling and Foundation</p> <p>IS:1080 Code of practice for design and construction of shallow foundations on soils.</p> <p>IS:1904 Code of practice for design and construction of foundation in Soils : General Requirements.</p> <p>IS:2314 Steel sheet piling sections.</p>			
<p>GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE</p>		<p>TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2</p>	<p>SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS</p>	<p>PAGE 12 OF 16</p>

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>IS:2911 Code of practice for design and construction of pile foundations. (Relevant Parts)</p> <p>IS:2950 Code of practice for designs and construction of Raft foundation.</p> <p>(Part-1) Design</p> <p>IS:2974 Code of practice for design and construction of machine foundation. (Part-1 to 5)</p> <p>IS:4091 Code of practice for design and construction foundations for transmission line towers and poles.</p> <p>IS:6403 Code of practice for determination of Bearing capacity of Shallow foundations.</p> <p>IS:8009 Code of practice for calculation of settlement of foundation.</p> <p>(Part -1) Shallow foundations.</p> <p>(Part -2) Deep foundations.</p> <p>IS:12070 Code of practice for design and construction of shallow foundations on rocks.</p> <p>ISO 10816 Criteria for assessing mechanical vibrations of machines.</p> <p>ISO 1940 Criteria for assessing the st of balance of rotating rigid bodies.</p> <p>DIN : EN 13906-1 Helical compression spring made of round wire and rod : calculation and design of compression .</p> <p>DIN:2096 Helical compression spring out of round wire and rod : Quality requirements for hot formed compression spring.</p> <p>DIN:4024 Flexible supporting structures for machine with rotating machines.</p> <p>Roads</p> <p>IRC:5 Standard specifications and Code of practice for road bridges, (Section-1) General Features of Design.</p> <p>IRC:14 Recommended practice for 2cm thick bitumen and tar carpets.</p> <p>IRC:15 Standard specifications and code of practice for construction of concrete roads.</p> <p>IRC:16 Specification for priming of base course with bituminous primers.</p> <p>IRC:19 Standard specifications and Code of practice for water bound macadam.</p> <p>IRC:21 Standard specifications and Code of practice for road bridges. (Section-III) Cement concrete (plain and reinforced).</p> <p>IRC:34 Recommendations for road construction in water logged areas.</p>			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2		SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>IRC:36 Recommended practice for the construction of earth embankments for road works.</p> <p>IRC:37 Guidelines for the Design of flexible pavements.</p> <p>IRC:56 Recommended practice for treatment of embankment slopes for erosion control.</p> <p>IRC:58 Guidelines for the design of rigid pavements for highways.</p> <p>IRC:73 Geometric Design standards for rural (non-urban) highways.</p> <p>IRC : 86 Geometric Design standards for urban roads in plains.</p> <p>IRC:SP:13 Guidelines for the design of small bridges & culverts.</p> <p>IRC - Publication Ministry of Surface Transport (Road wing), specifications for road and bridge works.</p> <p>IS:73 Paving bitumen.</p> <p>Loading</p> <p>IS:875 Code of practice for design loads (other than earthquake) for (Relevant parts) buildings and structures.</p> <p>IS:1893 Criteria for earthquake resistant design of structures.</p> <p>IS:4091 Code of practice for design and construction of foundation for transmission line towers and poles.</p> <p>IRC:6 (Section-II) Standard specifications & Code of practice for road bridges. loads and stresses</p> <p>Safety</p> <p>IS:1641 Code of practice for fire safety of buildings - General principles of fire grading and classification.</p> <p>IS:1642 Code of practice for fire safety of buildings - Details of construction.</p> <p>IS:3696 (Part-1&2) Safety code for scaffolds and ladders.</p> <p>IS:3764 Excavation work - code of safety.</p> <p>IS:4081 Safety code for blasting and related drilling operations.</p> <p>IS:4130 Demolition of buildings - code of safety.</p> <p>IS:5121 Safety code for piling and other deep foundations.</p> <p>IS:5916 Safety code for construction involving use of hot bituminous materials.</p>			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2		SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<div>IS:7205 Safety code for erection of structural steel work.</div> <div>IS:7293 Safety code for working with construction machinery.</div> <div>IS:7969 Safety code for handling and storage of building materials. Indian Explosives (As updated) Act 1940)</div> <div>Architectural Design of Buildings</div> <div>SP:7 National Building Code of India</div> <div>SP:41 Hand book on functional requirements of buildings (other than industrial buildings)</div> <div>ECBC Energy Conservation Building Code</div> <div>GRIHA Green Rating For Integrated Habitat Assessment.</div> <div>Tall Structures, Chimneys</div> <div>IS:4998 Criteria for design of reinforced chimneys</div> <div>IS:6533 Code of practice for design and construction of steel chimneys</div> <div>ICAO International Civil Aviation Organisation (ICAO)</div> <div>DGCA Instruction of Director General of Civil Aviation , India</div> <div>ACI:307 Specification for the design and construction of reinforced concrete chimneys</div> <div>BS:4076 Specification for steel chimneys</div> <div>CICIND Model Code for concrete chimneys Model code for steel chimneys</div> <div>ASCE Code Design and construction of steel chimney liners prepared by Task committee on steel chimney liners. Fossil power committee, Power division published by ASCE - 1975.</div> <div>IS:1554 PVC insulated (heavy duty) electric cables</div> <div>IS:2606 Alloy lead anodes for chromium plating</div> <div>IS:3043 Code of Practice for Earthing</div> <div>IS:9537 Conduits for electrical installations. The Indian Electricity Rules The Indian Electricity Act The Indian Electricity (Supply) Act The Indian Factories Act</div> <div>IS:2309 Practice for protection of buildings and allied structures against lightning</div>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2	SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS	PAGE 15 OF 16

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<p>Miscellaneous</p> <p>IS:802 (Relevant parts) Code of practice for use of structural steel in overhead trans- mission line towers.</p> <p>IS:803 Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.</p> <p>IS:10430 Criteria for design of lined canals and guidance for selection of type of lining.</p> <p>IS:11592 Code of practice for selection and design of belt conveyors.</p> <p>IS:12867 PVC handrails covers.</p> <p>IS 11504 Criteria for structural design of reinforced concrete natural draught cooling towers</p> <p>BS:4485 (IV) British Standard : Code of design for water cooling towers</p> <p>CIRIA Publication IS 4671 Design and construction of buried thin-wall pipes.</p> <p>IS 4671 Expanded polystyrene for thermal insulation purposes.</p> <p>IS 18299 structural design and proof checking consultancy services for structures.</p>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO: CS-6401-001-2	SUB-SECTION-D-1-9(A) CIVIL WORKS Annex(A)-LIST OF CODES AND STANDARDS	PAGE 16 OF 16

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ANNEXURE-B

CONSTRUCTION METHODOLOGY

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC	
D-1-9	<p style="text-align: right;">Annexure- B</p> <p style="text-align: center;">CONSTRUCTION METHODOLOGY</p> <p>Construction and erection activities shall be fully mechanized from the start of the work.</p> <p>All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, poclains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer.</p> <p>For controlled rock blasting specialized agency, equipped with sensors to assess the impact of the blast on the adjoining existing structures, shall be employed.</p> <p>Dewatering shall be done using the combination of electrical and standby diesel pumps.</p> <p>Pile installation equipment suitable for flushing with air lift technique shall be used for construction of bored piles.</p> <p>For concrete, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.</p> <p>All fabrication and erection activities of structural steel shall be carried out using automatic submerged arc welding machines, cutting machines, gantry cranes, crawler mounted heavy cranes and other equipment like heavy plate bending machines, shearing machines, lathe, milling machines, etc. Use of derricks shall not be permitted. Special enclosures, for blast cleaning of steel structure surface preparation, shall be used.</p> <p>All handling of materials shall be with cranes. Heavy trailers shall be used for transportation.</p> <p>Mechanized modular units of scaffolding and shuttering shall be used.</p> <p>Grouting shall be carried out using hydraulically controlled grouting equipment.</p> <p>Roadwork shall be done using pavers, rollers and premix plant.</p> <p>All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.</p> <p>Heavy duty hoists for lifting of construction materials shall be deployed. Compressors for cleaning of foundations and other surfaces shall be used.</p> <p>Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc. For testing of steel works, ultrasonic testing machines, radiographic testing machines, dye penetration test equipment, destruction testing equipment, etc. shall be deployed.</p> <p>All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.</p>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART B BID DOC NO: CS-6401-001-2	SUB-SECTION-D-1-9 (B) CIVIL WORKS CONSTRUCTION METHODOLOGY	Page 1 of 1

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ANNEXURE-C

GEO-TECH REPORT

ANNEXURE -C

GEO TECHNICAL INVESTIGATION REPORT

Report on
GEOTECHNICAL INVESTIGATION WORK FOR A PROPOSED
108 MW GAS BASED POWER PLANT IN GREAT NICOBAR
ISLAND, INDIA

Client:



Consultant:

FICHTNER CONSULTING ENGINEERS INDIA PVT. LTD.

Site Study Sub Vendor:



Jabakusum House, 34, C. R. Avenue
Kolkata - 700 012,
PH. 033- 4065 8074
Email - info@geosolutionindia.com
Website - www.geosolutionindia.com



GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

PART – 1
REPORT ON SUB – SOIL TEST

PART – 2
REPORT ON EARTH RESISTIVITY TEST

PART – 3
REPORT ON PERMEABILITY TEST

PART – 4
REPORT ON SUB-SOIL TEST OF SUB-STATIONS

PART – 5
REPORT ON TRIAL PIT



GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
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DATE	September, 2025

REPORT PREPARED BY:-

(DIPANKAR DEY TAFARDER)



(SOUMITRA KUMAR KUNDU)



(PRANAB KUMAR DAS)



(RAHUL SEN)

PART – 1

REPORT ON SUB – SOIL TEST

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-01 (Rev.01)
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Report (Rev.01) on

Geotechnical Investigation for 108 MW Gas based Power Plant at Great Nicobar Island, India

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1.2 Location		
1.3 Climate		
1.4 Purpose & Scope of Services		
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2.1 Topography		
2.2 Geology		
2.3 Seismicity		
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ANNEXURE

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FIGURE

Borehole Location Plan	Fig. 1
Graphical Borehole Log	Fig. 2

REFERENCE



GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

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1.0 INTRODUCTION

1.1 General

NTPC Limited (A Government of India Enterprise) is contemplating to set-up power infrastructure in multiple phases with LNG based Gas Engine, PV Solar and Transmission System at Great Nicobar Island as per the mandate from MoP under the plan for Holistic Development of Great Nicobar Island. M/s Fichtner Consulting Engineers (India) Pvt. Ltd. has been emerged as owner's consultant for preparation of Detailed Project Report (DPR) for the said project. M/s Fichtner has selected M/s Geosolution Proservices Pvt. Ltd. (GPPL) for conducting field studies pertaining to DPR preparation. This report has been prepared for partial fulfillment of field studies for DPR preparation.

1.2 Location

Great Nicobar Island is the southernmost and largest island of the Nicobar Islands group which is part of the Andaman and Nicobar Islands, a union territory of India. It lies in the Bay of Bengal, approximately 150 km north of Sumatra, Indonesia. The island's coordinates are roughly 6.8° N latitude and 93.8° E longitude. Notably, Indira Point, located on Great Nicobar, is the southernmost point of India.

The project site is located in the southern part of the Great Nicobar Island, the coordinate is 6.828392° N, 93.844112° E. The project site is located in and around Galathea Bay.

The site can be accessed by a metalled road from Campbell Bay. Campbell Bay is connected to Port Blair through Ship and Helicopter Services.

1.3 Climate

The climate of the site area is tropical.

1.4 Purpose & Scope of Services

NTPC is planning to set up 108MW LNG based engine power plant at Great Nicobar Island (GNI). As a part of preparation of Detailed Project Report (DPR), Geotechnical investigation needed to be carried out.

Geotechnical investigation by drilling boreholes has been undertaken to evaluate the design parameters required for foundation design and other related activities. Altogether twenty two boreholes have to be drilled at the proposed site. Officials of

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M/s Fichtner Consulting Engineers (India) Pvt. Ltd have fixed up the borehole numbers, locations and their depth. This report has been prepared based on twenty two boreholes. The boreholes location has been presented in Fig.1 & Annexure – I.

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2.0 SITE CONDITION**2.1 Topography**

Topographically the site area is predominantly hilly and undulating.

2.2 Geology

Geologically, Great Nicobar Island is part of an island arc formed by the collision of the Indo-Australian Plate with the Eurasian Plate. This tectonic activity has given rise to a series of highlands and islands, including the Andaman and Nicobar Islands. The island features mountainous terrain, with elevations reaching up to approximately 650 meters above sea level.

2.3 Seismicity

The site area falls at the transition of Seismic zone V (as per IS: 1893; Part – 1: 2002). These regions are most susceptible to major earthquakes (magnitude > 7.0). So, proper infrastructure design and mitigation technique is needed to protect or minimize the effect of earthquake and associated tsunami effect.

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3.0 METHODS OF INVESTIGATION

3.1 Boring – Drilling

Boring has been done by using a mechanized rig. Boring rods are raised and lowered by means of shear legs and a power winch. The casing is advanced by driving by means of a monkey suspended from winch. Core drilling has been undertaken for penetrating through hard strata. Drilling was done by rotary core drilling method deploying 'Geo' core drilling rig. Core drilling is a process in which a sampler, consisting of a double tube (core barrel) with a cutting bit at its end, cuts annular hole in a rock mass thereby creating a cylinder or core of rocks which is recovered in the core barrel. Both TC and diamond bits were used during the drilling operation. All boreholes were systematically logged and boring data were noted. Borehole logs are presented in the Annexure – II.

3.2 Standard Penetration Test (SPT)

These tests were conducted in the boreholes at regular intervals or the change of strata; it was carried out by standard sampler (a split-spoon sampler) of standard design and dimension (50 mm OD and 35 mm ID, with minimum length of 450 mm). The sampler was driven by a 63.5 kg drive weight (monkey) as per guidelines laid in IS: 2131. As per the IS code of practice for this test, the monkey was allowed to fall on the top of the drill rod from a height of 750 mm several times until the sample penetrates about 150 mm into the soil as a seating drive. The numbers of blows required to drive the spoon from 150 mm to 450 mm i.e., beyond the seating drive, were recorded and this number of blows is called 'N' value or Standard Penetration Test (SPT) value of the sub-soil at that particular depth. Where the test has been carried out on completion of a test, the split spoon sampler was brought out of the borehole and opened the same. The collected soil sample from the split spoon sampler was preserved in air tight polythene packets for classification purpose. The samples were labeled properly with the project name, borehole and the depth of sampling.

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Followings are the corrections on SPT values in cohesion-less soil:

1. Due to overburden: N value for cohesion-less soil shall be corrected for overburden as per Fig. 1 of IS: 2131 (N').
2. Due to Dilatancy: The values corrected for overburden shall be corrected for dilatancy if the stratum consists of fine sand and silt below water table for values of N' greater than 15, as under (N''): $N'' = 15 + 0.5 \cdot (N' - 15)$

Typical calculation for N value correction:

BH No.- 9. Depth: 6.00 m. Field N = 22. Water table: 0.00 m below EGL.

Effective OVP at the average depth: = 4.80 t/m^2 .

From Fig 1. of IS: 2131, correction factor = 1.25

So corrected SPT value for overburden, $N' = 1.25 \times 22 = 27.44$.

Correction for dilatancy = $15 + (27.44 - 15) / 2 = 21.22$.

Same calculation will be valid for other N values in sandy layer.

Stratum wise corrected "N" values are presented in tabular form given below:

Stratum No.	Stratum Description	"N" Values		
		Average	Maximum	Minimum
I	Silty clay/clayey silt	3	4	2
II	Loose to medium dense, silty sand	20	36	5
III	Decomposed sedimentary rock	31	81	21
IV	Weathered sedimentary rock	100	100	100

Note: N Value means Standard Penetration Test (SPT) Values

All the correction in detail is presented in a tabular form below in Table – 1.

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BH No.	Start Depth (m)	Field N	OVP (t/m ²)	OVP Corr. Factor	Correction		Corrected N	Stratum No
					Overburden	Dilatancy		
1	1.50	9	1.20	1.71	15.40	15.20	15	II
	3.00	11	2.40	1.48	16.27	15.63	16	II
	4.50	19	3.60	1.34	25.53	20.26	20	II
	6.00	100	4.80	1.25	124.72	69.86	70	III
	7.50	100	6.08	1.17	116.85	65.92	66	III
	9.00	100	7.35	1.10	110.48	62.74	63	III
3	1.50	10	1.60	1.61	16.15	15.57	16	II
	3.00	100	2.80	1.43	142.75	78.87	79	III
	4.50	100	4.08	1.30	130.20	72.60	73	III
	6.00	100	5.35	1.21	121.10	68.05	68	III
	7.50	100	6.63	1.14	113.95	64.47	64	III
	9.00	100	--	--	--	--	100	IV
	10.50	100	--	--	--	--	100	IV
	12.00	100	--	--	--	--	100	IV
	13.50	100	--	--	--	--	100	IV
	15.00	100	--	--	--	--	100	IV
4	1.50	13	1.20	1.71	22.24	18.62	19	II
	3.00	15	2.40	1.48	22.19	18.59	19	II
	4.50	10	3.60	1.34	13.43	14.22	14	II
	6.00	17	4.80	1.25	21.20	18.10	18	II
	7.50	48	6.00	1.17	56.29	35.64	36	III
	9.00	72	7.28	1.11	79.79	47.39	47	III
	10.50	100	8.55	1.05	105.42	60.21	60	III
	12.00	100	9.83	1.01	100.77	57.88	58	III
	13.50	100	11.10	0.97	96.69	55.84	56	III
	15.00	100	12.38	0.93	93.05	54.03	54	III
5	1.50	9	1.20	1.71	15.40	15.20	15	II
	3.00	11	2.40	1.48	16.27	15.63	16	II
	4.50	18	3.60	1.34	24.18	19.59	20	II
	6.00	24	4.80	1.25	29.93	22.47	22	II
	7.50	100	6.00	1.17	117.26	66.13	66	III
	9.00	100	7.28	1.11	110.82	62.91	63	III
	10.50	100	8.55	1.05	105.42	60.21	60	III
	12.00	100	9.83	1.01	100.77	57.88	58	III
	13.50	55	11.10	0.97	53.18	34.09	34	III
	15.00	58	12.38	0.93	53.97	34.49	34	III
	16.50	64	13.65	0.90	57.46	36.23	36	III
	18.00	100	14.93	0.87	86.79	50.89	51	III
	19.50	100	16.20	0.84	84.05	49.52	50	III
	21.00	100	17.48	0.82	81.51	48.26	48	III
	22.50	100	18.75	0.79	79.16	47.08	47	III
	24.00	100	20.03	0.77	76.96	45.98	46	III
	25.00	100	20.88	0.76	75.57	45.28	45	III

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BH No.	Start Depth (m)	Field N	OVP (t/m ²)	OVP Corr. Factor	Correction		Corrected N	Stratum No
					Overburden	Dilatancy		
6	1.50	13	1.52	1.63	21.21	18.11	18	II
	3.00	100	2.72	1.44	143.72	79.36	79	III
	4.50	100	4.00	1.31	130.86	72.93	73	III
	6.00	100	5.27	1.22	121.60	68.30	68	III
	7.50	100	6.55	1.14	114.35	64.68	65	III
7	1.50	8	1.20	1.71	13.69	--	14	II
	3.00	100	2.40	1.48	147.90	81.45	81	III
	4.50	100	3.68	1.34	133.65	74.33	74	III
8	1.50	16	1.40	1.66	26.55	20.77	21	II
	3.00	21	2.60	1.45	30.50	22.75	23	II
	4.50	19	3.80	1.33	25.18	20.09	20	II
	6.00	100	5.00	1.23	123.36	69.18	69	III
	7.50	100	6.28	1.16	115.76	65.38	65	III
	9.00	100	7.55	1.10	109.58	62.29	62	III
	10.50	100	8.83	1.04	104.36	59.68	60	III
	12.00	100	10.10	1.00	99.85	57.42	57	III
	13.50	100	11.38	0.96	95.87	55.44	55	III
	15.00	100	12.65	0.92	92.32	53.66	54	III
	16.50	100	13.93	0.89	89.11	52.05	52	III
	18.00	100	15.20	0.86	86.18	50.59	51	III
	19.50	100	16.48	0.83	83.48	49.24	49	III
	21.00	100	17.75	0.81	80.99	48.00	48	III
	22.50	100	19.03	0.79	78.67	46.84	47	III
9	1.50	3	1.20	1.71	5.13	--	5	II
	3.00	9	2.40	1.48	13.31	--	13	II
	4.50	14	3.60	1.34	18.81	16.90	17	II
	6.00	22	4.80	1.25	27.44	21.22	21	II
	7.50	34	6.00	1.17	39.87	27.43	27	III
	9.00	37	7.28	1.11	41.00	28.00	28	III
	10.50	37	8.55	1.05	39.00	27.00	27	III
	12.00	49	9.83	1.01	49.38	32.19	32	III
	13.50	44	11.10	0.97	42.54	28.77	29	III
	15.00	48	12.38	0.93	44.67	29.83	30	III
	16.50	45	13.65	0.90	40.40	27.70	28	III
	18.00	52	14.93	0.87	45.13	30.06	30	III
	19.50	45	16.20	0.84	37.82	26.41	26	III
	21.00	55	17.48	0.82	44.83	29.92	30	III
	22.50	62	18.75	0.79	49.08	32.04	32	III
10	1.50	33	1.48	1.64	54.18	34.59	35	III
	3.00	38	2.75	1.43	54.47	34.74	35	III
	4.50	34	4.03	1.31	44.41	29.70	30	III
	6.00	37	5.30	1.21	44.92	29.96	30	III
	7.50	39	6.58	1.14	44.54	29.77	30	III
	9.00	41	7.85	1.08	44.39	29.70	30	III
	10.50	43	9.13	1.03	44.39	29.70	30	III
	12.00	44	10.40	0.99	43.50	29.25	29	III
	13.50	42	11.68	0.95	39.90	27.45	27	III
	15.00	46	12.95	0.92	42.11	28.55	29	III
	16.50	48	14.23	0.88	42.43	28.71	29	III
	18.00	51	15.50	0.86	43.62	29.31	29	III
	19.50	49	16.78	0.83	40.61	27.81	28	III
	21.00	100	18.05	0.80	80.43	47.72	48	III
	22.50	100	19.33	0.78	78.15	46.57	47	III
	24.00	100	20.60	0.76	76.01	45.51	46	III
	25.00	100	21.45	0.75	74.66	44.83	45	III

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					Overburden	Dilatancy		
11	1.50	28	1.50	1.64	45.81	30.41	30	II
	3.00	29	2.70	1.44	41.75	28.37	28	II
	4.50	47	3.90	1.32	61.88	38.44	38	III
	6.00	54	5.18	1.22	65.99	40.50	40	III
	7.50	54	6.45	1.15	62.02	38.51	39	III
	9.00	100	7.73	1.09	108.81	61.91	62	III
	10.50	100	9.00	1.04	103.70	59.35	59	III
	12.00	20	10.28	0.99	19.85	17.43	17	II
	13.50	22	11.48	0.96	21.03	18.01	18	II
	15.00	21	12.68	0.92	19.37	17.19	17	II
	16.50	25	13.88	0.89	22.31	18.65	19	II
	18.00	27	15.08	0.86	23.34	19.17	19	II
	19.50	28	16.28	0.84	23.49	19.24	19	II
	21.00	34	17.48	0.82	27.71	21.36	21	III
	22.50	35	18.75	0.79	27.71	21.35	21	III
	24.00	41	20.03	0.77	31.55	23.28	23	III
	25.00	39	20.88	0.76	29.47	22.24	22	III
12	1.50	30	1.68	1.60	47.98	31.49	31	III
	3.00	33	2.95	1.41	46.53	30.77	31	III
	4.50	36	4.23	1.29	46.44	30.72	31	III
	6.00	38	5.50	1.20	45.67	30.33	30	III
	7.50	16	6.78	1.13	18.11	16.56	17	II
	9.00	15	7.98	1.08	16.16	15.58	16	II
	10.50	17	9.18	1.03	17.52	16.26	16	II
	12.00	18	10.38	0.99	17.81	16.41	16	II
	13.50	20	11.58	0.95	19.06	17.03	17	II
	15.00	22	12.78	0.92	20.24	17.62	18	II
	16.50	24	13.98	0.89	21.36	18.18	18	II
	18.00	26	15.18	0.86	22.42	18.71	19	II
	19.50	29	16.38	0.84	24.27	19.63	20	II
	21.00	33	17.58	0.81	26.84	20.92	21	III
	22.50	33	18.85	0.79	26.06	20.53	21	III
	24.00	38	20.13	0.77	29.18	22.09	22	III
	25.00	41	20.98	0.75	30.92	22.96	23	III
13	1.50	13	1.40	1.66	21.57	18.29	18	II
	3.00	15	2.60	1.45	21.78	18.39	18	II
	4.50	21	3.80	1.33	27.83	21.42	21	II
	6.00	25	5.00	1.23	30.84	22.92	23	II
	7.50	35	6.20	1.16	40.66	27.83	28	III
	9.00	43	7.48	1.10	47.26	31.13	31	III
	10.50	36	8.75	1.05	37.67	26.34	26	III
	12.00	34	10.03	1.00	34.03	24.52	25	III
	13.50	38	11.30	0.96	36.52	25.76	26	III
	15.00	37	12.58	0.93	34.23	24.62	25	III
	16.50	39	13.85	0.89	34.82	24.91	25	III
	18.00	41	15.13	0.86	35.40	25.20	25	III
	19.50	44	16.40	0.84	36.80	25.90	26	III
	21.00	48	17.68	0.81	38.94	26.97	27	III
	22.50	52	18.95	0.79	40.98	27.99	28	III
	24.00	56	20.23	0.77	42.91	28.96	29	III
	25.00	60	21.08	0.75	45.15	30.07	30	III

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					Overburden	Dilatancy		
14	1.50	22	1.50	1.64	36.00	25.50	25	II
	3.00	31	2.70	1.44	44.63	29.81	30	III
	4.50	38	3.98	1.31	49.79	32.40	32	III
	6.00	45	5.25	1.22	54.78	34.89	35	III
	7.50	39	6.53	1.14	44.64	29.82	30	III
	9.00	100	--	--	--	--	100	IV
	10.50	100	--	--	--	--	100	IV
	12.00	100	--	--	--	--	100	IV
	13.50	100	--	--	--	--	100	IV
	15.00	100	--	--	--	--	100	IV
15	16.50	100	--	--	--	--	100	IV
	18.00	100	--	--	--	--	100	IV
	1.50	25	1.40	1.66	41.48	28.24	28	II
	3.00	40	2.60	1.45	58.09	36.55	37	III
	4.50	49	3.88	1.32	64.62	39.81	40	III
	6.00	52	5.15	1.22	63.63	39.32	39	III
	7.50	47	6.43	1.15	54.04	34.52	35	III
	9.00	13	7.70	1.09	14.16	--	14	II
	10.50	100	8.98	1.04	103.80	59.40	59	III
	12.00	100	10.25	0.99	99.35	57.18	57	III
	13.50	36	11.53	0.95	34.36	24.68	25	III
	15.00	47	12.80	0.92	43.20	29.10	29	III
	16.50	41	14.08	0.89	36.39	25.69	26	III
	18.00	57	15.35	0.86	48.93	31.97	32	III
	19.50	46	16.63	0.83	38.26	26.63	27	III
16	21.00	45	17.90	0.81	36.32	25.66	26	III
	22.50	50	19.18	0.78	39.20	27.10	27	III
	24.00	53	20.45	0.76	40.42	27.71	28	III
	25.00	49	21.30	0.75	36.70	25.85	26	III
	1.50	35	1.48	1.64	57.46	36.23	36	III
	3.00	40	2.75	1.43	57.34	36.17	36	III
	4.50	24	4.03	1.31	31.35	23.17	23	II
	6.00	27	5.23	1.22	32.91	23.95	24	II
	7.50	30	6.43	1.15	34.49	24.75	25	II
	9.00	32	7.63	1.09	34.96	24.98	25	II
	10.50	28	8.83	1.04	29.22	22.11	22	II
	12.00	31	10.03	1.00	31.03	23.01	23	III
	13.50	34	11.30	0.96	32.67	23.84	24	III
	15.00	36	12.58	0.93	33.31	24.15	24	III
	16.50	35	13.85	0.89	31.25	23.13	23	III
17	18.00	39	15.13	0.86	33.67	24.34	24	III
	19.50	41	16.40	0.84	34.29	24.65	25	III
	21.00	44	17.68	0.81	35.70	25.35	25	III
	22.50	46	18.95	0.79	36.25	25.62	26	III
	24.00	50	20.23	0.77	38.31	26.66	27	III
	25.00	53	21.08	0.75	39.88	27.44	27	III
	1.50	19	1.20	1.71	32.51	23.75	24	II
17	3.00	26	2.40	1.48	38.45	26.73	27	II
	4.50	100	--	--	--	--	100	IV
	6.00	100	--	--	--	--	100	IV
	7.50	100	--	--	--	--	100	IV
	9.00	100	--	--	--	--	100	IV
	10.50	100	--	--	--	--	100	IV

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					Overburden	Dilatancy		
18	1.50	16	1.20	1.71	27.37	21.19	21	II
	3.00	25	2.40	1.48	36.98	25.99	26	II
	4.50	100	--	--	--	--	100	IV
	6.00	100	--	--	--	--	100	IV
	7.50	100	--	--	--	--	100	IV
	9.00	100	--	--	--	--	100	IV
	10.50	100	--	--	--	--	100	IV
	12.00	100	--	--	--	--	100	IV
	13.50	100	--	--	--	--	100	IV
	15.00	100	--	--	--	--	100	IV
21	1.50	23	1.20	1.71	39.35	27.17	27	II
	3.00	41	2.40	1.48	60.64	37.82	38	III
	4.50	36	3.68	1.34	48.12	31.56	32	III
	6.00	25	4.95	1.24	30.92	22.96	23	II
	7.50	27	6.15	1.16	31.44	23.22	23	II
	9.00	23	7.35	1.10	25.41	20.20	20	II
	10.50	100	8.55	1.05	105.42	60.21	60	III
	12.00	100	9.83	1.01	100.77	57.88	58	III
	13.50	100	11.10	0.97	96.69	55.84	56	III
	15.00	47	12.38	0.93	43.74	29.37	29	III
	16.50	50	13.65	0.90	44.89	29.94	30	III
	18.00	61	14.93	0.87	52.94	33.97	34	III
	19.50	100	16.20	0.84	84.05	49.52	50	III
	20.00	100	16.63	0.83	83.18	49.09	49	III
22	1.50	2	--	--	--	--	2	I
	3.00	2	--	--	--	--	2	I
	4.50	4	--	--	--	--	4	I
	6.00	100	--	--	--	--	100	IV
	7.50	100	--	--	--	--	100	IV
	9.00	100	--	--	--	--	100	IV
	10.50	100	--	--	--	--	100	IV
	12.00	100	--	--	--	--	100	IV
	13.50	100	--	--	--	--	100	IV
	15.00	100	--	--	--	--	100	IV
	16.50	100	--	--	--	--	100	IV
	18.00	100	--	--	--	--	100	IV
	19.50	100	--	--	--	--	100	IV
	21.00	100	--	--	--	--	100	IV
	22.50	100	--	--	--	--	100	IV
	24.00	100	--	--	--	--	100	IV
	25.00	100	--	--	--	--	100	IV
23	1.50	10	1.20	1.71	17.11	16.05	16	II
	3.00	46	2.40	1.48	68.04	41.52	42	III
	4.50	100	--	--	--	--	100	IV
	6.00	100	--	--	--	--	100	IV
	7.50	100	--	--	--	--	100	IV
	9.00	100	--	--	--	--	100	IV



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BH No.	Start Depth (m)	Field N	OVP (t/m ²)	OVP Corr. Factor	Correction		Corrected N	Stratum No
					Overburden	Dilatancy		
24	1.50	28	1.20	1.71	47.90	31.45	31	II
	3.00	39	2.40	1.48	57.68	36.34	36	II
	4.50	24	3.60	1.34	32.24	23.62	24	II
	6.00	27	4.80	1.25	33.68	24.34	24	II
	7.50	29	6.00	1.17	34.01	24.50	25	II
	9.00	22	7.20	1.11	24.46	19.73	20	II
	10.50	43	8.40	1.06	45.58	30.29	30	III
	12.00	100	9.68	1.01	101.28	58.14	58	III
	13.50	100	10.95	0.97	97.14	56.07	56	III
	15.00	100	12.23	0.93	93.46	54.23	54	III
	16.50	43	13.50	0.90	38.76	26.88	27	III
	18.00	34	14.78	0.87	29.62	22.31	22	III
	19.50	38	16.05	0.84	32.06	23.53	24	III
	20.00	44	16.48	0.83	36.73	25.87	26	III
25	1.50	10	1.20	1.71	17.11	16.05	16	II
	3.00	16	2.40	1.48	23.66	19.33	19	II
	4.50	39	3.60	1.34	52.39	33.70	34	III
	6.00	52	4.88	1.24	64.59	39.79	40	III
	7.50	55	6.15	1.16	64.04	39.52	40	III
	9.00	100	7.43	1.10	110.14	62.57	63	III
	10.50	100	8.70	1.05	104.84	59.92	60	III
	12.00	100	9.98	1.00	100.26	57.63	58	III
	13.50	100	11.25	0.96	96.24	55.62	56	III
	15.00	100	12.53	0.93	92.65	53.83	54	III

Table – 1: Correction of field N values.

The corrected and uncorrected SPT curve has been presented in the Annexure – III.

3.3 Sampling

Undisturbed sampling was attempted during boring but due high sand and moisture content and loose nature, undisturbed samples could not be collected properly. Mainly SPT and core samples were collected during drilling work. Those samples have been relied upon for understanding the properties of the sub-soil profile. SPT and core samples were used both for visual identification and laboratory test. Disturbed samples were also collected from boreholes which have been mainly used for visual identification.

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3.4 Water Table Observation

Water levels in the boreholes were observed during and after completion of boring operation. The final water levels were recorded in the field and are shown in the individual logs.

3.5 Laboratory Investigation

The following laboratory tests were conducted as per the provision of different sections of relevant IS codes (IS: 2720) to determine the index and the relevant engineering properties of the subsurface deposits and subsequently to finalize the foundation parameters.

For soil samples

- (a) Grain size analysis.
- (b) Test for liquid limit, plastic limit.
- (c) Test for Specific Gravity
- (d) Direct shear / Triaxial test for Cohesion & Angle of internal friction
- (e) Density Test.

Laboratory data on soil samples have been presented in the Annexure – IV.

For rock samples

- a) Porosity
- b) Hardness
- c) Specific gravity
- d) Density
- e) Point load strength index
- f) Unconfined compression test
- g) Water Content
- h) Slake Durability Index
- i) Deformability

Laboratory test on rock samples have been presented in the Annexure – V.

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4.0 RESULTS OF INVESTIGATION

4.1 General

This chapter contains discussion on results of sub-soil exploration. Geotechnical investigation by drilling boreholes has been conducted at proposed site. The objective of the investigation was overall assessment of sub-soil conditions and evaluation of foundation parameters. For evaluation of foundation parameters, sub-soil profile was established first. Analyses of various sub-soil data lead to selection and evaluation of foundation design parameters.

4.2 Sub-Soil Profile

Depending on field observation and laboratory test results the sub-soil deposits of the mentioned twenty two numbers of borehole are classified into different strata. The borehole data indicate more or less similar sub-soil stratification. Altogether five strata have been identified. Stratum wise description has been presented below.

Stratum I – Clayey silt

This stratum consists of brownish grey, wet, soft to very soft, clayey silt with sand & decomposed wood. This stratum has been significantly encountered in 1 out of 22 boreholes.

Stratum II – Silty sand

This stratum consists of brownish grey, wet, loose to medium dense, silty fine sand. This stratum has been significantly encountered in 20 out of 22 boreholes.

Stratum III – Decomposed sedimentary rock

This stratum consists of brownish grey, wet, dense to very dense, silty fine sand. This layer has been termed as decomposed sedimentary rock material. This layer is behaves as sandy horizon. This stratum has been encountered in 19 out of 22 boreholes.

Stratum IV – Weathered sedimentary rock

This stratum consists of brownish grey, wet, dense, weathered sedimentary rock. This stratum has been encountered in 6 out of 22 boreholes.

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Stratum V – Sedimentary Rock

This stratum consists of brownish grey, moderately to partially weathered sedimentary rock (shale / siltstone). Rock core has been recovered from this stratum. This stratum has been significantly encountered in 10 out of 22 boreholes.

Borehole wise stratification is presented below.

Sl. No.	BH. No.	Strata Thickness (m)				
		S – I	S – II	S – III	S – IV	S – V
		Clayey silt	Silty sand	Decomposed sedimentary	Weathered sedimentary	Rock
1	BH – 1	---	6.00	3.50	---	10.50 *
2	BH – 3	---	3.00	5.00	7.50	9.50 *
3	BH – 4	---	7.50	8.00	---	4.50 *
4	BH – 5	---	7.50	17.50 *	---	---
5	BH – 6	---	3.00	5.00	---	12.00 *
6	BH – 7	---	3.00	2.00	---	15.00 *
7	BH – 8	---	6.00	19.00 *	---	---
8	BH – 9	---	7.50	17.50 *	---	---
9	BH – 10	---	---	25.00 *	---	---
10	BH – 11	---	4.50 + 9.00	7.50 + 4.00 *	---	---
11	BH – 12	---	13.50	7.50 + 4.00*	---	---
12	BH – 13	---	7.50	17.50 *	---	---
13	BH – 14	---	3.00	6.00	9.50	6.50 *
14	BH – 15	---	3.00 + 1.50	6.00 + 14.50 *	---	---
15	BH – 16	---	7.50	4.50 + 13.00 *	---	---
16	BH – 17	---	4.50	---	6.50	14.00 *
17	BH – 18	---	4.50	---	11.00	9.50 *
18	BH – 21	---	3.00 + 4.50	3.00 + 9.50 *	---	---
19	BH – 22	6.00	---	---	19.00 *	---
20	BH – 23	---	3.00	1.50	5.00	15.50 *
21	BH – 24	---	10.50	9.50 *	---	---
22	BH – 25	---	4.50	11.00	---	4.50 *

*strata continues below termination depth.

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4.3 Sub-soil Properties

Stratum – II (silty sand), stratum – III (decomposed sedimentary), stratum – IV (weathered sedimentary) are important from foundation point of view. Generalized sub-soil properties for stratum – II, III, & IV have been presented below.

Stratum II

Average corrected “N” = 20. Corresponding $\Phi = 33.00^\circ$ [Ref: Fig.1 of IS 6403]

So considering the subsoil, lab result, probable clay content and to be on the safer side, Use, design $C = 0.00 \text{ kg/cm}^2$ & $\Phi = 31.50^\circ$. Corresponding design corrected “N” = 14.

Stratum III

Average corrected “N” = 31. Corresponding $\Phi = 36.00^\circ$ [Ref: Fig.1 of IS 6403]

So considering the subsoil, lab result, probable clay content and to be on the safer side, Use, design $C = 0.00 \text{ kg/cm}^2$ & $\Phi = 33.00^\circ$. Corresponding design corrected “N” = 20.

Stratum IV

The weathered rock may be treated as soil [Refer IS 12070, Clause 7.1].

From literature we know that C and Φ value of rock specimen ranges from $C = 3.5$ to 17.5 MPa and Φ seldom less than 40°

[Refer Bowles, J.E., Foundation Analysis and Design, 5th Edition, pp-278]

As the rock in the present case is weathered, cohesion will not be there. So, considering rock quality and to be on the safer side, use, $C = 0.00 \text{ t/m}^2$ & $\Phi = 35^\circ$. Corresponding design corrected “N” = 25.

4.4 Geohydrological Condition

Water levels in the boreholes were observed during and after completion of boring operation. The final water levels were recorded in the field and are shown in the individual bore logs. Borehole wise water table has been presented in tabular form.

Borehole No.	Water Table (m) (begl)	Borehole No.	Water Table (m) (begl)
BH – 1	0.00	BH – 5	0.00
BH – 3	0.40	BH – 6	0.32
BH – 4	0.00	BH – 7	0.00

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Borehole No.	Water Table (m) (begl)	Borehole No.	Water Table (m) (begl)
BH – 8	0.20	BH – 16	0.20
BH – 9	0.00	BH – 17	0.00
BH – 10	0.20	BH – 18	0.00
BH – 11	0.30	BH – 21	0.00
BH – 12	0.40	BH – 22	0.00
BH – 13	0.20	BH – 23	0.00
BH – 14	0.30	BH – 24	0.00
BH – 15	0.20	BH – 25	0.00

4.5 Susceptibility of Subsoil to Liquefaction

The present site is under seismic zone – V. The liquefaction potential of subsoil is evaluated as per provision laid down in Indian Standard **[IS: 1893 (Part – 1) 2016]** and “*Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils*” by Dr. Gonzalo Castro et al. published in “*Journal of Geotechnical and Geo-environmental Engineering*”, October’ 2001. Based on the SPT values, the liquefaction resistance of the borehole was evaluated for zone – V as per IS: 1893 Part – I and presented below. The ratio of $CRR/CSR \leq 1.0$ indicates that the soil is prone to liquefaction whereas $CRR/CSR > 1.0$ or corrected $N_1 > 30$ indicates the soil is non liquefiable. Based on the above, the liquefaction resistance of the subsoil is determined and presented below.

As per H. B. Seed and I.M. Idriss (1982) a clayey soil is said to be non-liquefiable if any one of the following three criteria is satisfied.

- the soil contains fine grained soils with clay contents greater than 15%,
- liquid limit greater than 35% or
- Moisture contents less than 90% of the liquid limit.

In the present case, Stratum-I is having more than 15 % of clay content. So this layer is non-liquefiable. For Stratum – II, III & IV, the liquefaction potential has been evaluated as follows.

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Zone: V			a _{max} /g	0.36	Earthquake magnitude =							7.50			Bulk density =			1.85		
BH No.	Depth (m)	Field N	Total OVP (t/sqm)	Effective OVP (t/sqm)	C _N	C _{HT}	C _{HW}	C _{BD}	C _{SS}	C _{RD}	(N ₁) ₆₀	FC	α	β	(N ₁) _{60CS}	r _d	CSR	CRR _{7.5}	FOS	REMARKS
BH-1	1.50	9	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	9.8	21	3.78	1.09	14.4	0.99	0.50	0.15	0.306	Liquifiable
	3.00	11	5.55	2.55	1.70	0.75	0.98	1.05	1.10	0.80	12.8	21	3.78	1.09	17.6	0.98	0.50	0.19	0.376	Liquifiable
	4.50	19	8.33	3.83	1.62	0.75	0.98	1.05	1.10	0.85	22.3	21	3.78	1.09	28.0	0.97	0.49	0.37	0.746	Liquifiable
	6.00	100	11.10	5.10	1.40	0.75	0.98	1.05	1.20	0.95	123.7	18	3.23	1.07	135.2	(N1)60CS>30				Non Liquifiable
	7.50	100	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	110.7	18	3.23	1.07	121.2					Non Liquifiable
	9.00	100	16.65	7.65	1.14	0.75	0.98	1.05	1.20	0.95	101.0	18	3.23	1.07	111.0					Non Liquifiable
BH-3	1.50	10	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	10.9	21	3.78	1.09	15.6	0.99	0.50	0.17	0.329	Liquifiable
	3.00	100	5.55	2.55	1.70	0.75	0.98	1.05	1.20	0.80	126.5	18	3.23	1.07	138.1	(N1)60CS>30				Non Liquifiable
	4.50	100	8.33	3.83	1.62	0.75	0.98	1.05	1.20	0.85	129.9	18	3.23	1.07	141.7					Non Liquifiable
	6.00	100	11.10	5.10	1.40	0.75	0.98	1.05	1.20	0.95	125.7	18	3.23	1.07	137.3					Non Liquifiable
	7.50	100	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	112.4	18	3.23	1.07	123.1	Non Liquifiable				
	9.00	100	Weathered rock																	Non Liquifiable
	10.50	100																		Non Liquifiable
	12.00	100																		Non Liquifiable
	13.50	100																		Non Liquifiable
	15.00	100																		Non Liquifiable
BH-4	1.50	13	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	14.4	21	3.78	1.09	19.4	0.99	0.50	0.21	0.412	Liquifiable
	3.00	15	5.55	2.55	1.70	0.75	0.98	1.05	1.10	0.80	17.7	21	3.78	1.09	23.0	0.98	0.50	0.26	0.514	Liquifiable
	4.50	10	8.33	3.83	1.62	0.75	0.98	1.05	1.10	0.85	11.9	21	3.78	1.09	16.7	0.97	0.49	0.18	0.360	Liquifiable
	6.00	17	11.10	5.10	1.40	0.75	0.98	1.05	1.10	0.95	19.6	21	3.78	1.09	25.1	0.96	0.49	0.29	0.601	Liquifiable
	7.50	48	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	54.0	18	3.23	1.07	60.8	(N1)60CS>30				Non Liquifiable
	9.00	72	16.65	7.65	1.14	0.75	0.98	1.05	1.20	0.95	73.9	18	3.23	1.07	82.0					Non Liquifiable
	10.50	100	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	100.0	18	3.23	1.07	109.9					Non Liquifiable
	12.00	100	22.20	10.20	0.99	0.75	0.98	1.05	1.20	1.00	93.6	18	3.23	1.07	103.0					Non Liquifiable
	13.50	100	24.98	11.48	0.93	0.75	0.98	1.05	1.20	1.00	88.2	18	3.23	1.07	97.3					Non Liquifiable
	15.00	100	27.75	12.75	0.89	0.75	0.98	1.05	1.20	1.00	83.7	18	3.23	1.07	92.5					Non Liquifiable
BH-5	1.50	9	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	9.9	21	3.78	1.09	14.6	0.99	0.50	0.16	0.309	Liquifiable
	3.00	11	5.55	2.55	1.70	0.75	0.98	1.05	1.10	0.80	13.0	21	3.78	1.09	17.9	0.98	0.50	0.19	0.381	Liquifiable
	4.50	18	8.33	3.83	1.62	0.75	0.98	1.05	1.10	0.85	21.4	21	3.78	1.09	27.1	0.97	0.49	0.34	0.689	Liquifiable
	6.00	24	11.10	5.10	1.40	0.75	0.98	1.05	1.10	0.95	27.7	21	3.78	1.09	33.8	(N1)60CS>30				Non Liquifiable
	7.50	100	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	112.4	18	3.23	1.07	123.1					Non Liquifiable
	9.00	100	16.65	7.65	1.14	0.75	0.98	1.05	1.20	0.95	102.6	18	3.23	1.07	112.7					Non Liquifiable
	10.50	100	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	100.0	18	3.23	1.07	109.9					Non Liquifiable
	12.00	100	22.20	10.20	0.99	0.75	0.98	1.05	1.20	1.00	93.6	18	3.23	1.07	103.0					Non Liquifiable
	13.50	55	24.98	11.48	0.93	0.75	0.98	1.05	1.20	1.00	48.5	18	3.23	1.07	55.0					Non Liquifiable
	15.00	58	27.75	12.75	0.89	0.75	0.98	1.05	1.20	1.00	48.5	18	3.23	1.07	55.0					Non Liquifiable
	16.50	64	30.53	14.03	0.84	0.75	0.98	1.05	1.20	1.00	51.1	18	3.23	1.07	57.7					Non Liquifiable
	18.00	100	33.30	15.30	0.81	0.75	0.98	1.05	1.20	1.00	76.4	18	3.23	1.07	84.7					Non Liquifiable
	19.50	100	36.08	16.58	0.78	0.75	0.98	1.05	1.20	1.00	73.4	18	3.23	1.07	81.5					Non Liquifiable
	21.00	100	38.85	17.85	0.75	0.75	0.98	1.05	1.20	1.00	70.7	18	3.23	1.07	78.7					Non Liquifiable
	22.50	100	41.63	19.13	0.72	0.75	0.98	1.05	1.20	1.00	68.3	18	3.23	1.07	76.1					Non Liquifiable
	24.00	100	44.40	20.40	0.70	0.75	0.98	1.05	1.20	1.00	66.2	18	3.23	1.07	73.8					Non Liquifiable
	25.00	100	46.25	21.25	0.69	0.75	0.98	1.05	1.20	1.00	64.8	18	3.23	1.07	72.4					Non Liquifiable
BH-6	1.50	13	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	14.4	21	3.78	1.09	19.4	0.99	0.50	0.21	0.412	Liquifiable
	3.00	100	5.55	2.55	1.70	0.75	0.98	1.05	1.20	0.80	128.5	18	3.23	1.07	140.3	(N1)60CS>30				Non Liquifiable
	4.50	100	8.33	3.83	1.62	0.75	0.98	1.05	1.20	0.85	129.9	18	3.23	1.07	141.7					Non Liquifiable
	6.00	100	11.10	5.10	1.40	0.75	0.98	1.05	1.20	0.95	125.7	18	3.23	1.07	137.3					Non Liquifiable
	7.50	100	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	112.4	18	3.23	1.07	123.1					Non Liquifiable
BH-7	1.50	8	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	8.8	21	3.78	1.09	13.4	0.99	0.50	0.14	0.286	Liquifiable
	3.00	100	5.55	2.55	1.70	0.75	0.98	1.05	1.20	0.80	128.5	18	3.23	1.07	140.3	(N1)60CS>30				Non Liquifiable
	4.50	100	8.33	3.83	1.62	0.75	0.98	1.05	1.20	0.85	129.9	18	3.23	1.07	141.7					Non Liquifiable



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Zone: V			a _{max} /g	0.36	Earthquake magnitude =							7.50				Bulk density =			1.85						
BH No.	Depth (m)	Field N	Total OVP (t/sqm)	Effective OVP (t/sqm)	C _N	C _{HT}	C _{HW}	C _{BD}	C _{SS}	C _{RD}	(N ₁) ₆₀	FC	α	β	(N ₁) _{60CS}	r _d	CSR	CRR _{7.5}	FOS	REMARKS					
BH-8	1.50	16	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	17.7	21	3.78	1.09	23.0	0.99	0.50	0.26	0.509	Liquifiable					
	3.00	21	5.55	2.55	1.70	0.75	0.98	1.05	1.10	0.80	24.7	21	3.78	1.09	30.7	0.98	0.50	0.52	1.045	Non Liquifiable					
	4.50	19	8.33	3.83	1.62	0.75	0.98	1.05	1.10	0.85	22.6	21	3.78	1.09	28.3	0.97	0.49	0.38	0.775	Liquifiable					
	6.00	100	11.10	5.10	1.40	0.75	0.98	1.05	1.20	0.95	125.7	18	3.23	1.07	137.3	(N1)60CS>30					Non Liquifiable				
	7.50	100	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	112.4	18	3.23	1.07	123.1						Non Liquifiable				
	9.00	100	16.65	7.65	1.14	0.75	0.98	1.05	1.20	0.95	102.6	18	3.23	1.07	112.7						Non Liquifiable				
	10.50	100	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	100.0	18	3.23	1.07	109.9						Non Liquifiable				
	12.00	100	22.20	10.20	0.99	0.75	0.98	1.05	1.20	1.00	93.6	18	3.23	1.07	103.0						Non Liquifiable				
	13.50	100	24.98	11.48	0.93	0.75	0.98	1.05	1.20	1.00	88.2	18	3.23	1.07	97.3						Non Liquifiable				
	15.00	100	27.75	12.75	0.89	0.75	0.98	1.05	1.20	1.00	83.7	18	3.23	1.07	92.5						Non Liquifiable				
	16.50	100	30.53	14.03	0.84	0.75	0.98	1.05	1.20	1.00	79.8	18	3.23	1.07	88.3						Non Liquifiable				
	18.00	100	33.30	15.30	0.81	0.75	0.98	1.05	1.20	1.00	76.4	18	3.23	1.07	84.7						Non Liquifiable				
	19.50	100	36.08	16.58	0.78	0.75	0.98	1.05	1.20	1.00	73.4	18	3.23	1.07	81.5						Non Liquifiable				
	21.00	100	38.85	17.85	0.75	0.75	0.98	1.05	1.20	1.00	70.7	18	3.23	1.07	78.7						Non Liquifiable				
	22.50	100	41.63	19.13	0.72	0.75	0.98	1.05	1.20	1.00	68.3	18	3.23	1.07	76.1						Non Liquifiable				
24.00	100	44.40	20.40	0.70	0.75	0.98	1.05	1.20	1.00	66.2	18	3.23	1.07	73.8	Non Liquifiable										
25.00	100	46.25	21.25	0.69	0.75	0.98	1.05	1.20	1.00	64.8	18	3.23	1.07	72.4	Non Liquifiable										
BH-9	1.50	3	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	3.3	21	3.78	1.09	7.3	0.99	0.50	0.09	0.179	Liquifiable					
	3.00	9	5.55	2.55	1.70	0.75	0.98	1.05	1.10	0.80	10.4	21	3.78	1.09	15.1	0.98	0.50	0.16	0.323	Liquifiable					
	4.50	14	8.33	3.83	1.62	0.75	0.98	1.05	1.10	0.85	16.4	21	3.78	1.09	21.6	0.97	0.49	0.24	0.479	Liquifiable					
	6.00	22	11.10	5.10	1.40	0.75	0.98	1.05	1.10	0.95	25.0	21	3.78	1.09	30.9	(N1)60CS>30					Non Liquifiable				
	7.50	34	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	37.6	18	3.23	1.07	43.4						Non Liquifiable				
	9.00	37	16.65	7.65	1.14	0.75	0.98	1.05	1.20	0.95	37.4	18	3.23	1.07	43.1						Non Liquifiable				
	10.50	37	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	36.4	18	3.23	1.07	42.1						Non Liquifiable				
	12.00	49	22.20	10.20	0.99	0.75	0.98	1.05	1.20	1.00	45.1	18	3.23	1.07	51.4						Non Liquifiable				
	13.50	44	24.98	11.48	0.93	0.75	0.98	1.05	1.20	1.00	38.8	18	3.23	1.07	44.6						Non Liquifiable				
	15.00	48	27.75	12.75	0.89	0.75	0.98	1.05	1.20	1.00	40.2	18	3.23	1.07	46.1						Non Liquifiable				
	16.50	45	30.53	14.03	0.84	0.75	0.98	1.05	1.20	1.00	35.9	18	3.23	1.07	41.5						Non Liquifiable				
	18.00	52	33.30	15.30	0.81	0.75	0.98	1.05	1.20	1.00	39.7	18	3.23	1.07	45.6						Non Liquifiable				
	19.50	45	36.08	16.58	0.78	0.75	0.98	1.05	1.20	1.00	33.0	18	3.23	1.07	38.5						Non Liquifiable				
	21.00	55	38.85	17.85	0.75	0.75	0.98	1.05	1.20	1.00	38.9	18	3.23	1.07	44.7						Non Liquifiable				
	22.50	62	41.63	19.13	0.72	0.75	0.98	1.05	1.20	1.00	42.4	18	3.23	1.07	48.4						Non Liquifiable				
24.00	68	44.40	20.40	0.70	0.75	0.98	1.05	1.20	1.00	45.0	18	3.23	1.07	51.2	Non Liquifiable										
25.00	79	46.25	21.25	0.69	0.75	0.98	1.05	1.20	1.00	51.2	18	3.23	1.07	57.8	Non Liquifiable										
BH-10	1.50	33	2.78	1.28	1.70	0.75	0.98	1.05	1.20	0.75	39.8	18	3.23	1.07	45.6	(N1)60CS>30					Non Liquifiable				
	3.00	38	5.55	2.55	1.70	0.75	0.98	1.05	1.20	0.80	48.8	18	3.23	1.07	55.3						Non Liquifiable				
	4.50	34	8.33	3.83	1.62	0.75	0.98	1.05	1.20	0.85	44.2	18	3.23	1.07	50.3						Non Liquifiable				
	6.00	37	11.10	5.10	1.40	0.75	0.98	1.05	1.20	0.95	46.5	18	3.23	1.07	52.8						Non Liquifiable				
	7.50	39	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	43.9	18	3.23	1.07	50.0						Non Liquifiable				
	9.00	41	16.65	7.65	1.14	0.75	0.98	1.05	1.20	0.95	42.1	18	3.23	1.07	48.1						Non Liquifiable				
	10.50	43	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	43.0	18	3.23	1.07	49.1						Non Liquifiable				
	12.00	44	22.20	10.20	0.99	0.75	0.98	1.05	1.20	1.00	41.2	18	3.23	1.07	47.1						Non Liquifiable				
	13.50	42	24.98	11.48	0.93	0.75	0.98	1.05	1.20	1.00	37.1	18	3.23	1.07	42.7						Non Liquifiable				
	15.00	46	27.75	12.75	0.89	0.75	0.98	1.05	1.20	1.00	38.5	18	3.23	1.07	44.3						Non Liquifiable				
	16.50	48	30.53	14.03	0.84	0.75	0.98	1.05	1.20	1.00	38.3	18	3.23	1.07	44.1						Non Liquifiable				
	18.00	51	33.30	15.30	0.81	0.75	0.98	1.05	1.20	1.00	39.0	18	3.23	1.07	44.8						Non Liquifiable				
	19.50	49	36.08	16.58	0.78	0.75	0.98	1.05	1.20	1.00	36.0	18	3.23	1.07	41.6						Non Liquifiable				
	21.00	100	38.85	17.85	0.75	0.75	0.98	1.05	1.20	1.00	70.7	18	3.23	1.07	78.7						Non Liquifiable				
	22.50	100	41.63	19.13	0.72	0.75	0.98	1.05	1.20	1.00	68.3	18	3.23	1.07	76.1						Non Liquifiable				
24.00	100	44.40	20.40	0.70	0.75	0.98	1.05	1.20	1.00	66.2	18	3.23	1.07	73.8	Non Liquifiable										
25.00	100	46.25	21.25	0.69	0.75	0.98	1.05	1.20	1.00	64.8	18	3.23	1.07	72.4	Non Liquifiable										
BH-11	1.50	28	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	30.9	21	3.78	1.09	37.4	(N1)60CS>30					Non Liquifiable				
	3.00	29	5.55	2.55	1.70	0.75	0.98	1.05	1.10	0.80	34.2	21	3.78	1.09	40.9						Non Liquifiable				
	4.50	47	8.33	3.83	1.62	0.75	0.98	1.05	1.20	0.85	61.0	18	3.23	1.07	68.3						Non Liquifiable				
	6.00	54	11.10	5.10	1.40	0.75	0.98	1.05	1.20	0.95	67.9	18	3.23	1.07	75.6						Non Liquifiable				
	7.50	54	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	60.7	18	3.23	1.07	68.0						Non Liquifiable				
	9.00	100	16.65	7.65	1.14	0.75	0.98	1.05	1.20	0.95	102.6	18	3.23	1.07	112.7						Non Liquifiable				
	10.50	100	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	100.0	18	3.23	1.07	109.9						Non Liquifiable				
	12.00	20	22.20	10.20	0.99	0.75	0.98	1.05	1.10	1.00	17.2	21	3.78	1.09	22.4	0.86	0.44	0.25	0.569	Liquifiable					
	13.50	22	24.98	11.48	0.93	0.75	0.98	1.05	1.10	1.00	17.8	21	3.78	1.09	23.1	0.81	0.41	0.26	0.626	Liquifiable					
	15.00	21	27.75	12.75	0.89	0.75	0.98	1.05	1.10	1.00	16.1	21	3.78	1.09	21.3	0.76	0.39	0.23	0.599	Liquifiable					
	16.50	25	30.53	14.03	0.84	0.75	0.98	1.05	1.10	1.00	18.3	21	3.78	1.09	23.6	0.71	0.36	0.27	0.738	Liquifiable					
	18.00	27	33.30	15.30	0.81	0.75	0.98	1.05	1.10	1.00	18.9	21	3.78	1.09	24.3	0.67	0.34	0.28	0.821	Liquifiable					
	19.50	28	36.08	16.58	0.78	0.75	0.98	1.05	1.10	1.00	18.8	21	3.78	1.09	24.2	0.63	0.32	0.28	0.867	Liquifiable					
	21.00	34	38.85	17.85	0.75	0.75	0.98	1.05	1.20	1.00	24.0	18	3.23	1.07	28.9	0.60	0.30	0.40	1.329	Non Liquifiable					
	22.50	35	41.63	19.13	0.72	0.75	0.98	1.05	1.20	1.00	23.9	18	3.23	1.07	28.7	0.57	0.29	0.40	1.365	Non Liquifiable					
24.00	41	44.40	20.40	0.70	0.75	0.98	1.05	1.20	1.00	27.1	18	3.23	1.07	32.2	(N1)60CS>30					Non Liquifiable					
25.00	39	46.25	21.25	0.69	0.75	0.98	1.05	1.20	1.00	25.3	18	3.23	1.07	30.2						Non Liquifiable					
BH-12	1.50	30	2.78	1.28	1.70	0.75	0.98	1.05	1.20	0.75	36.1	18	3.23	1.07	41.8	(N1)60CS>30					Non Liquifiable				
	3.00	33	5.55	2.55	1.70	0.75	0.98	1.05	1.20	0.80	42.4	18	3.23	1.07	48.5						Non Liquifiable				
	4.50	36	8.33	3.83	1.62	0.75	0.98	1.05	1.20	0.85	46.8	18	3.23	1.07	53.1						Non Liquifiable				
	6.00	38	11.10	5.10	1.40	0.75	0.98	1.05	1.20	0.95	47.8	18	3.23	1.07	54.2						Non Liquifiable				
	7.50	16	13.88	6.38	1.25	0.75	0.98	1.05	1.10	0.95	16.5	21	3.78	1.09	21.7						0.94	0.48	0.24	0.495	Liquifiable
	9.00	15	16.65	7.65	1.14	0.75	0.98	1.05	1.10	0.95	14.1	21	3.78	1.09	19.1						0.92	0.47	0.20	0.435	Liquifiable
	10.50	17	19.43	8.93	1.06	0.75	0.98	1.05	1.10	1.00	15.6	21	3.78	1.09	20.7						0.89	0.46	0.22	0.493	Liquifiable
	12.00	18	22.20	10.20	0.99	0.75	0.98	1.05	1.10	1.00	15.4	21	3.78	1.09	20.5	0.86	0.44	0.22	0.510	Liquifiable					
	13.50	20	24.98	11.48	0.93	0.75	0.98	1.05	1.10	1.00	16.2	21	3.78	1.09	21.3	0.81	0.41	0.23	0.564	Liquifiable					



GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

Zone: V			a _{max} /g	0.36	Earthquake magnitude =								7.50				Bulk density =				1.85			
BH No.	Depth (m)	Field N	Total OVP (t/sqm)	Effective OVP (t/sqm)	C _N	C _{HT}	C _{HW}	C _{BD}	C _{SS}	C _{RD}	(N ₁) ₆₀	FC	α	β	(N ₁) _{60CS}	r _d	CSR	CRR _{7.5}	FOS	REMARKS				
BH-13	1.50	13	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	14.1	21	3.78	1.09	19.1	0.99	0.50	0.20	0.406	Liquifiable				
	3.00	15	5.55	2.55	1.70	0.75	0.98	1.05	1.10	0.80	17.4	21	3.78	1.09	22.7	0.98	0.50	0.25	0.505	Liquifiable				
	4.50	21	8.33	3.83	1.62	0.75	0.98	1.05	1.10	0.85	24.6	21	3.78	1.09	30.5	(N1)60CS>30					Non Liquifiable			
	6.00	25	11.10	5.10	1.40	0.75	0.98	1.05	1.10	0.95	28.4	21	3.78	1.09	34.6						Non Liquifiable			
	7.50	35	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	38.7	18	3.23	1.07	44.5						Non Liquifiable			
	9.00	43	16.65	7.65	1.14	0.75	0.98	1.05	1.20	0.95	43.4	18	3.23	1.07	49.6						Non Liquifiable			
	10.50	36	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	35.4	18	3.23	1.07	41.0						Non Liquifiable			
	12.00	34	22.20	10.20	0.99	0.75	0.98	1.05	1.20	1.00	31.3	18	3.23	1.07	36.6						Non Liquifiable			
	13.50	38	24.98	11.48	0.93	0.75	0.98	1.05	1.20	1.00	33.5	18	3.23	1.07	39.0						Non Liquifiable			
	15.00	37	27.75	12.75	0.89	0.75	0.98	1.05	1.20	1.00	31.0	18	3.23	1.07	36.3						Non Liquifiable			
	16.50	39	30.53	14.03	0.84	0.75	0.98	1.05	1.20	1.00	31.1	18	3.23	1.07	36.4						Non Liquifiable			
	18.00	41	33.30	15.30	0.81	0.75	0.98	1.05	1.20	1.00	31.3	18	3.23	1.07	36.6						Non Liquifiable			
	19.50	44	36.08	16.58	0.78	0.75	0.98	1.05	1.20	1.00	32.3	18	3.23	1.07	37.7						Non Liquifiable			
	21.00	48	38.85	17.85	0.75	0.75	0.98	1.05	1.20	1.00	34.0	18	3.23	1.07	39.4						Non Liquifiable			
22.50	52	41.63	19.13	0.72	0.75	0.98	1.05	1.20	1.00	35.5	18	3.23	1.07	41.1	Non Liquifiable									
24.00	56	44.40	20.40	0.70	0.75	0.98	1.05	1.20	1.00	37.1	18	3.23	1.07	42.7	Non Liquifiable									
25.00	60	46.25	21.25	0.69	0.75	0.98	1.05	1.20	1.00	38.9	18	3.23	1.07	44.7	Non Liquifiable									
BH-14	1.50	22	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	24.3	21	3.78	1.09	30.2	0.99	0.50	0.48	0.952	Liquifiable				
	3.00	31	5.55	2.55	1.70	0.75	0.98	1.05	1.20	0.80	39.8	18	3.23	1.07	45.7	(N1)60CS>30				Non Liquifiable				
	4.50	38	8.33	3.83	1.62	0.75	0.98	1.05	1.20	0.85	49.4	18	3.23	1.07	55.9					Non Liquifiable				
	6.00	45	11.10	5.10	1.40	0.75	0.98	1.05	1.20	0.95	56.6	18	3.23	1.07	63.6					Non Liquifiable				
	7.50	39	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	43.9	18	3.23	1.07	50.0					Non Liquifiable				
	9.00	100	Weathered rock																	Non Liquifiable				
	10.50	100																		Non Liquifiable				
	12.00	100																		Non Liquifiable				
	13.50	100																		Non Liquifiable				
	15.00	100																		Non Liquifiable				
	16.50	100	Non Liquifiable																					
18.00	100	Non Liquifiable																						
BH-15	1.50	25	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	27.6	21	3.78	1.09	33.8	(N1)60CS>30				Non Liquifiable				
	3.00	40	5.55	2.55	1.70	0.75	0.98	1.05	1.20	0.80	51.4	18	3.23	1.07	58.1					Non Liquifiable				
	4.50	49	8.33	3.83	1.62	0.75	0.98	1.05	1.20	0.85	63.6	18	3.23	1.07	71.1					Non Liquifiable				
	6.00	52	11.10	5.10	1.40	0.75	0.98	1.05	1.20	0.95	65.4	18	3.23	1.07	72.9					Non Liquifiable				
	7.50	47	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	52.8	18	3.23	1.07	59.6	0.92	0.47	0.18	0.386	Liquifiable				
	9.00	13	16.65	7.65	1.14	0.75	0.98	1.05	1.10	0.95	12.2	21	3.78	1.09	17.1	(N1)60CS>30				Non Liquifiable				
	10.50	100	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	100.0	18	3.23	1.07	109.9					Non Liquifiable				
	12.00	100	22.20	10.20	0.99	0.75	0.98	1.05	1.20	1.00	93.6	18	3.23	1.07	103.0					Non Liquifiable				
	13.50	36	24.98	11.48	0.93	0.75	0.98	1.05	1.20	1.00	31.8	18	3.23	1.07	37.1					Non Liquifiable				
	15.00	47	27.75	12.75	0.89	0.75	0.98	1.05	1.20	1.00	39.3	18	3.23	1.07	45.2					Non Liquifiable				
	16.50	41	30.53	14.03	0.84	0.75	0.98	1.05	1.20	1.00	32.7	18	3.23	1.07	38.1					Non Liquifiable				
	18.00	57	33.30	15.30	0.81	0.75	0.98	1.05	1.20	1.00	43.5	18	3.23	1.07	49.7					Non Liquifiable				
	19.50	46	36.08	16.58	0.78	0.75	0.98	1.05	1.20	1.00	33.8	18	3.23	1.07	39.2					Non Liquifiable				
	21.00	45	38.85	17.85	0.75	0.75	0.98	1.05	1.20	1.00	31.8	18	3.23	1.07	37.2					Non Liquifiable				
22.50	50	41.63	19.13	0.72	0.75	0.98	1.05	1.20	1.00	34.2	18	3.23	1.07	39.7	Non Liquifiable									
24.00	53	44.40	20.40	0.70	0.75	0.98	1.05	1.20	1.00	35.1	18	3.23	1.07	40.6	Non Liquifiable									
25.00	49	46.25	21.25	0.69	0.75	0.98	1.05	1.20	1.00	31.8	18	3.23	1.07	37.1	Non Liquifiable									
BH-16	1.50	35	2.78	1.28	1.70	0.75	0.98	1.05	1.20	0.75	42.2	18	3.23	1.07	48.2	(N1)60CS>30				Non Liquifiable				
	3.00	40	5.55	2.55	1.70	0.75	0.98	1.05	1.20	0.80	51.4	18	3.23	1.07	58.1					Non Liquifiable				
	4.50	24	8.33	3.83	1.62	0.75	0.98	1.05	1.10	0.85	28.6	21	3.78	1.09	34.8					Non Liquifiable				
	6.00	27	11.10	5.10	1.40	0.75	0.98	1.05	1.10	0.95	31.1	21	3.78	1.09	37.6					Non Liquifiable				
	7.50	30	13.88	6.38	1.25	0.75	0.98	1.05	1.10	0.95	30.9	21	3.78	1.09	37.4					Non Liquifiable				
	9.00	32	16.65	7.65	1.14	0.75	0.98	1.05	1.10	0.95	30.1	21	3.78	1.09	36.5					Non Liquifiable				
	10.50	28	19.43	8.93	1.06	0.75	0.98	1.05	1.10	1.00	25.7	21	3.78	1.09	31.7					Non Liquifiable				
	12.00	31	22.20	10.20	0.99	0.75	0.98	1.05	1.20	1.00	29.0	18	3.23	1.07	34.2					Non Liquifiable				
	13.50	34	24.98	11.48	0.93	0.75	0.98	1.05	1.20	1.00	30.0	18	3.23	1.07	35.2					Non Liquifiable				
	15.00	36	27.75	12.75	0.89	0.75	0.98	1.05	1.20	1.00	30.1	18	3.23	1.07	35.4					Non Liquifiable				
	16.50	35	30.53	14.03	0.84	0.75	0.98	1.05	1.20	1.00	27.9	18	3.23	1.07	33.0					Non Liquifiable				
	18.00	39	33.30	15.30	0.81	0.75	0.98	1.05	1.20	1.00	29.8	18	3.23	1.07	35.0					Non Liquifiable				
	19.50	41	36.08	16.58	0.78	0.75	0.98	1.05	1.20	1.00	30.1	18	3.23	1.07	35.3					Non Liquifiable				
	21.00	44	38.85	17.85	0.75	0.75	0.98	1.05	1.20	1.00	31.1	18	3.23	1.07	36.4					Non Liquifiable				
22.50	46	41.63	19.13	0.72	0.75	0.98	1.05	1.20	1.00	31.4	18	3.23	1.07	36.8	Non Liquifiable									
24.00	50	44.40	20.40	0.70	0.75	0.98	1.05	1.20	1.00	33.1	18	3.23	1.07	38.5	Non Liquifiable									
25.00	53	46.25	21.25	0.69	0.75	0.98	1.05	1.20	1.00	34.4	18	3.23	1.07	39.9	Non Liquifiable									
BH-17	1.50	19	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	20.7	21	3.78	1.09	26.2	0.99	0.50	0.32	0.631	Liquifiable				
	3.00	26	Weathered rock																	Non Liquifiable				
	4.50	100																		Non Liquifiable				
	6.00	100																		Non Liquifiable				
	7.50	100																		Non Liquifiable				
	9.00	100																		Non Liquifiable				
	10.50	100																		Non Liquifiable				
12.00	100	Non Liquifiable																						
13.50	100	Non Liquifiable																						
BH-18	1.50	16	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	17.7	21	3.78	1.09	23.0	0.99	0.50	0.26	0.509	Liquifiable				
	3.00	25	5.55	2.55	1.70	0.75	0.98	1.05	1.10	0.80	29.5	21	3.78	1.09	35.8	(N1)60CS>30				Non Liquifiable				
	4.50	100	Weathered rock																	Non Liquifiable				
	6.00	100																		Non Liquifiable				
	7.50	100																		Non Liquifiable				
	9.00	100																		Non Liquifiable				
	10.50	100																		Non Liquifiable				
	12.00	100																		Non Liquifiable				
13.50	100	Non Liquifiable																						
15.00	100	Non Liquifiable																						

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

Zone: V			a _{max} /g	0.36	Earthquake magnitude =							7.50					Bulk density =			1.85			
BH No.	Depth (m)	Field N	Total OVP (t/sqm)	Effective OVP (t/sqm)	C _N	C _{HT}	C _{HW}	C _{BD}	C _{SS}	C _{RD}	(N ₁) ₆₀	FC	α	β	(N ₁) _{60CS}	r _d	CSR	CRR _{7.5}	FOS	REMARKS			
BH-21	1.50	23	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	25.4	21	3.78	1.09	31.4	(N1)60CS>30					Non Liquefiable		
	3.00	41	5.55	2.55	1.70	0.75	0.98	1.05	1.20	0.80	52.7	18	3.23	1.07	59.4						Non Liquefiable		
	4.50	36	8.33	3.83	1.62	0.75	0.98	1.05	1.20	0.85	46.8	18	3.23	1.07	53.1						Non Liquefiable		
	6.00	25	11.10	5.10	1.40	0.75	0.98	1.05	1.10	0.95	28.8	21	3.78	1.09	35.1						Non Liquefiable		
	7.50	27	13.88	6.38	1.25	0.75	0.98	1.05	1.10	0.95	27.8	21	3.78	1.09	34.0						Non Liquefiable		
	9.00	23	16.65	7.65	1.14	0.75	0.98	1.05	1.10	0.95	21.6	21	3.78	1.09	27.3	0.92	0.47	0.35	0.737	Liquefiable			
	10.50	100	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	100.0	18	3.23	1.07	109.9	(N1)60CS>30					Non Liquefiable		
	12.00	100	22.20	10.20	0.99	0.75	0.98	1.05	1.20	1.00	93.6	18	3.23	1.07	103.0						Non Liquefiable		
	13.50	100	24.98	11.48	0.93	0.75	0.98	1.05	1.20	1.00	88.2	18	3.23	1.07	97.3						Non Liquefiable		
	15.00	47	27.75	12.75	0.89	0.75	0.98	1.05	1.20	1.00	39.3	18	3.23	1.07	45.2						Non Liquefiable		
	16.50	50	30.53	14.03	0.84	0.75	0.98	1.05	1.10	1.00	36.6	18	3.23	1.07	42.2						Non Liquefiable		
	18.00	61	33.30	15.30	0.81	0.75	0.98	1.05	1.20	1.00	46.6	18	3.23	1.07	52.9						Non Liquefiable		
19.50	100	36.08	16.58	0.78	0.75	0.98	1.05	1.20	1.00	73.4	18	3.23	1.07	81.5	Non Liquefiable								
20.00	100	37.00	17.00	0.77	0.75	0.98	1.05	1.20	1.00	72.5	18	3.23	1.07	80.5	Non Liquefiable								
BH-22	1.50	2																		Non Liquefiable			
	3.00	2																		Silty clay/clayey silt	Non Liquefiable		
	4.50	4																		Non Liquefiable			
	6.00	100																		Weathered rock	Non Liquefiable		
	7.50	100																			Non Liquefiable		
	9.00	100																			Non Liquefiable		
	10.50	100																			Non Liquefiable		
	12.00	100																			Non Liquefiable		
	13.50	100																			Non Liquefiable		
	15.00	100																			Non Liquefiable		
	16.50	100																			Non Liquefiable		
	18.00	100																			Non Liquefiable		
19.50	100	Non Liquefiable																					
21.00	100	Non Liquefiable																					
22.50	100	Non Liquefiable																					
24.00	100	Non Liquefiable																					
25.00	100	Non Liquefiable																					
BH-23	1.50	10	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	11.0	21	3.78	1.09	15.8	0.99	0.50	0.17	0.333	Liquefiable			
	3.00	46	5.55	2.55	1.70	0.75	0.98	1.05	1.20	0.80	59.1	18	3.23	1.07	66.3	(N1)60CS>30				Non Liquefiable			
	4.50																			Non Liquefiable			
	6.00																			Non Liquefiable			
	7.50																			Non Liquefiable			
	9.00																			Non Liquefiable			
	10.50																			Non Liquefiable			
12.00	Non Liquefiable																						
13.50	Non Liquefiable																						
BH-24	1.50	28	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	30.4	21	3.78	1.09	36.8	(N1)60CS>30					Non Liquefiable		
	3.00	39	5.55	2.55	1.70	0.75	0.98	1.05	1.10	0.80	45.2	21	3.78	1.09	52.9						Non Liquefiable		
	4.50	24	8.33	3.83	1.62	0.75	0.98	1.05	1.10	0.85	28.1	21	3.78	1.09	34.3						Non Liquefiable		
	6.00	27	11.10	5.10	1.40	0.75	0.98	1.05	1.10	0.95	30.6	21	3.78	1.09	37.0						Non Liquefiable		
	7.50	29	13.88	6.38	1.25	0.75	0.98	1.05	1.10	0.95	29.4	21	3.78	1.09	35.7						Non Liquefiable		
	9.00	22	16.65	7.65	1.14	0.75	0.98	1.05	1.10	0.95	20.4	21	3.78	1.09	25.9	0.92	0.47	0.31	0.662	Liquefiable			
	10.50	43	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	42.3	18	3.23	1.07	48.4	(N1)60CS>30					Non Liquefiable		
	12.00	100	22.20	10.20	0.99	0.75	0.98	1.05	1.20	1.00	92.1	18	3.23	1.07	101.4						Non Liquefiable		
	13.50	100	24.98	11.48	0.93	0.75	0.98	1.05	1.20	1.00	88.2	18	3.23	1.07	97.3						Non Liquefiable		
	15.00	100	27.75	12.75	0.89	0.75	0.98	1.05	1.20	1.00	83.7	18	3.23	1.07	92.5						Non Liquefiable		
	16.50	43	30.53	14.03	0.84	0.75	0.98	1.05	1.20	1.00	34.3	18	3.23	1.07	39.8						Non Liquefiable		
	18.00	34	33.30	15.30	0.81	0.75	0.98	1.05	1.20	1.00	26.0	18	3.23	1.07	30.9						Non Liquefiable		
19.50	38	36.08	16.58	0.78	0.75	0.98	1.05	1.20	1.00	27.9	18	3.23	1.07	33.0	Non Liquefiable								
20.00	44	37.00	17.00	0.77	0.75	0.98	1.05	1.20	1.00	31.9	18	3.23	1.07	37.2	Non Liquefiable								
BH-25	1.50	10	2.78	1.28	1.70	0.75	0.98	1.05	1.10	0.75	11.0	21	3.78	1.09	15.8	0.99	0.50	0.17	0.333	Liquefiable			
	3.00	16	5.55	2.55	1.70	0.75	0.98	1.05	1.10	0.80	18.8	21	3.78	1.09	24.3	0.98	0.50	0.28	0.557	Liquefiable			
	4.50	39	8.33	3.83	1.62	0.75	0.98	1.05	1.20	0.85	50.7	18	3.23	1.07	57.2	(N1)60CS>30					Non Liquefiable		
	6.00	52	11.10	5.10	1.40	0.75	0.98	1.05	1.20	0.95	65.4	18	3.23	1.07	72.9						Non Liquefiable		
	7.50	55	13.88	6.38	1.25	0.75	0.98	1.05	1.20	0.95	61.8	18	3.23	1.07	69.2						Non Liquefiable		
	9.00	100	16.65	7.65	1.14	0.75	0.98	1.05	1.20	0.95	102.6	18	3.23	1.07	112.7						Non Liquefiable		
	10.50	100	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	100.0	18	3.23	1.07	109.9						Non Liquefiable		
	12.00	100	22.20	10.20	0.99	0.75	0.98	1.05	1.20	1.00	93.6	18	3.23	1.07	103.0						Non Liquefiable		
	13.50	100	24.98	11.48	0.93	0.75	0.98	1.05	1.20	1.00	88.2	18	3.23	1.07	97.3						Non Liquefiable		
15.00	100	27.75	12.75	0.89	0.75	0.98	1.05	1.20	1.00	83.7	18	3.23	1.07	92.5	Non Liquefiable								



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Borehole wise liquefaction potential depth has been presented in tabular form.

Borehole No.	Depth of liquefaction potential (m)	Borehole No.	Depth of liquefaction potential (m)
BH – 1	0.00 – 5.00	BH – 13	0.00 – 3.50
BH – 3	0.00 – 2.00	BH – 14	0.00 – 2.00
BH – 4	0.00 – 6.50	BH – 15	--
BH – 5	0.00 – 5.00	BH – 16	--
BH – 6	0.00 – 2.00	BH – 17	0.00 – 2.00
BH – 7	0.00 – 2.00	BH – 18	0.00 – 2.00
BH – 8	0.00 – 5.00	BH – 21	--
BH – 9	0.00 – 5.00	BH – 22	--
BH – 10	--	BH – 23	0.00 – 2.00
BH – 11	12.00 – 20.00	BH – 24	--
BH – 12	7.50 – 20.00	BH – 25	0.00 – 3.50

4.6 Shallow Foundation

Shallow foundation of a stratum should satisfy two basic requirements. They are –

- There must be adequate safety against bearing capacity failure.
- Settlement of the foundation must be within the permissible limits.

Bearing capacity of a stratum can be computed based on following expression as per IS: 6403 – 1981:

$$q_{ult} = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma w'$$

where, q_{ult} = net ultimate bearing capacity

q = effective surcharge = $\gamma' d_f$

c = cohesion

γ = bulk density

N_c, N_q, N_γ = bearing capacity factors

s_c, s_q, s_γ = shape factors

d_c, d_q and d_γ are depth factors

d_f = depth of foundation

B = width of foundation

γ' = Effective density below foundation

w' = reduction factor for water table



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Settlement of foundation can be computed as per IS: 8009 (Part – I) – 1976.

Recommended Allowable bearing capacity values are as follows:

Location	Foundation Width (m)	Depth of Foundation below EGL (m)	Net Ultimate Bearing Capacity (t/m ²)	Net Safe Bearing Capacity (t/m ²)	Anticipated Settlement (mm)	Allowable Bearing Capacity for 25 mm settlement (t/m ²)	Allowable Bearing Capacity for 40 mm settlement (t/m ²)	Allowable Bearing Capacity for 75 mm settlement (t/m ²)
BH – 1	1.00 – 3.00	5.00	89.45	29.82	42.94	15.00	22.00	---
	3.00 – 6.00		76.51	25.50	38.25	16.50	24.00	---
	>6.00		84.00	28.00	47.60	---	---	25.00
	1.00 – 3.00	6.00	114.98	38.33	55.20	17.00	25.00	---
	3.00 – 6.00		128.02	42.67	55.30	18.00	26.00	---
	>6.00		135.19	45.06	72.10	---	---	28.00
BH – 3	1.00 – 3.00	3.00	65.96	21.99	23.75	20.00	20.00	---
	3.00 – 6.00		66.67	22.22	33.33	15.00	20.00	---
	>6.00		83.49	27.83	40.08	---	---	24.00
	1.00 – 3.00	4.00	147.31	49.10	42.42	23.00	26.00	---
	3.00 – 6.00		135.14	45.05	48.65	20.00	27.00	---
	>6.00		157.01	52.34	64.06	---	---	27.00
	1.00 – 3.00	5.00	197.82	65.94	56.97	24.00	27.00	---
	3.00 – 6.00		167.42	55.81	60.27	21.00	28.00	---
	>6.00		183.69	61.23	74.95	---	---	28.00
	1.00 – 3.00	6.00	255.11	85.04	73.47	25.00	28.00	---
	3.00 – 6.00		201.41	67.14	72.51	22.00	29.00	---
	>6.00		211.55	70.52	81.24	---	---	30.00
BH – 4	**							
	1.00 – 3.00	5.00	89.45	29.82	42.94	15.00	22.00	---
	3.00 – 6.00		76.51	25.50	38.25	16.50	24.00	---
BH – 5	>6.00		84.00	28.00	47.60	---	---	25.00
	1.00 – 3.00	6.00	114.98	38.33	55.20	17.00	25.00	---
	3.00 – 6.00		128.02	42.67	55.30	18.00	26.00	---
	>6.00		135.19	45.06	72.10	---	---	28.00

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Location	Foundation Width (m)	Depth of Foundation below EGL (m)	Net Ultimate Bearing Capacity (t/m ²)	Net Safe Bearing Capacity (t/m ²)	Anticipated Settlement (mm)	Allowable Bearing Capacity for 25 mm settlement (t/m ²)	Allowable Bearing Capacity for 40 mm settlement (t/m ²)	Allowable Bearing Capacity for 75 mm settlement (t/m ²)
BH – 6	1.00 – 3.00	3.00	65.96	21.99	23.75	20.00	20.00	---
	3.00 – 6.00		66.67	22.22	33.33	15.00	20.00	---
	>6.00		83.49	27.83	40.08	---	---	24.00
	1.00 – 3.00	4.00	147.31	49.10	42.42	23.00	26.00	---
	3.00 – 6.00		135.14	45.05	48.65	20.00	27.00	---
	>6.00		157.01	52.34	64.06	---	---	27.00
	1.00 – 3.00	5.00	197.82	65.94	56.97	24.00	27.00	---
	3.00 – 6.00		167.42	55.81	60.27	21.00	28.00	---
	>6.00		183.69	61.23	74.95	---	---	28.00
	1.00 – 3.00	6.00	255.11	85.04	73.47	25.00	28.00	---
	3.00 – 6.00		201.41	67.14	72.51	22.00	29.00	---
	>6.00		211.55	70.52	81.24	---	---	30.00
BH – 7	1.00 – 3.00	3.00	65.96	21.99	23.75	20.00	20.00	---
	3.00 – 6.00		66.67	22.22	33.33	15.00	20.00	---
	>6.00		83.49	27.83	40.08	---	---	24.00
	1.00 – 3.00	4.00	147.31	49.10	42.42	23.00	26.00	---
	3.00 – 6.00		135.14	45.05	48.65	20.00	27.00	---
	>6.00		157.01	52.34	64.06	---	---	27.00
	1.00 – 3.00	5.00	197.82	65.94	56.97	24.00	27.00	---
	3.00 – 6.00		167.42	55.81	60.27	21.00	28.00	---
	>6.00		183.49	61.23	74.95	---	---	28.00
	1.00 – 3.00	6.00	255.11	85.04	73.47	25.00	28.00	---
	3.00 – 6.00		201.41	67.14	72.51	22.00	29.00	---
	>6.00		211.55	70.52	81.24	---	---	30.00
BH – 8	1.00 – 3.00	5.00	89.45	29.82	42.94	15.00	22.00	---
	3.00 – 6.00		76.51	25.50	38.25	16.50	24.00	---
	>6.00		84.00	28.00	47.60	---	---	25.00
	1.00 – 3.00	6.00	114.98	38.33	55.20	17.00	25.00	---
	3.00 – 6.00		128.02	42.67	55.30	18.00	26.00	---
	>6.00		135.19	45.06	72.10	---	---	28.00
BH – 9	1.00 – 3.00	5.00	89.45	29.82	42.94	15.00	22.00	---
	3.00 – 6.00		76.51	25.50	38.25	16.50	24.00	---
	>6.00		84.00	28.00	47.60	---	---	25.00

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Location	Foundation Width (m)	Depth of Foundation below EGL (m)	Net Ultimate Bearing Capacity (t/m^2)	Net Safe Bearing Capacity (t/m^2)	Anticipated Settlement (mm)	Allowable Bearing Capacity for 25 mm settlement (t/m^2)	Allowable Bearing Capacity for 40 mm settlement (t/m^2)	Allowable Bearing Capacity for 75 mm settlement (t/m^2)
BH – 9	1.00 – 3.00	6.00	114.98	38.33	55.20	17.00	25.00	---
	3.00 – 6.00		128.02	42.67	55.30	18.00	26.00	---
	>6.00		135.19	45.06	72.10	---	---	28.00
BH – 10	1.00 – 3.00	2.00	66.88	22.29	16.05	20.00	20.00	---
	3.00 – 6.00		78.04	26.01	33.16	18.00	24.00	---
	>6.00		107.15	35.72	48.86	---	---	25.00
	1.00 – 3.00	3.00	103.58	34.53	29.83	22.00	24.00	---
	3.00 – 6.00		105.35	35.12	42.14	19.00	26.00	---
	>6.00		131.50	43.83	56.80	---	---	26.00
	1.00 – 3.00	4.00	147.31	49.10	42.42	23.00	26.00	---
	3.00 – 6.00		135.14	45.05	48.65	20.00	27.00	---
	>6.00		157.01	52.34	64.06	---	---	27.00
	1.00 – 3.00	5.00	197.82	65.94	56.97	24.00	27.00	---
	3.00 – 6.00		167.42	55.81	60.27	21.00	28.00	---
	>6.00		183.69	61.23	74.95	---	---	28.00
	1.00 – 3.00	6.00	255.11	85.04	73.47	25.00	28.00	---
	3.00 – 6.00		201.41	67.14	72.51	22.00	29.00	---
	>6.00		211.55	70.52	81.24	---	---	30.00
BH – 11	1.00 – 3.00	2.00	30.85	10.28	14.80	10.00	10.00	---
	3.00 – 6.00		35.11	11.70	19.89	11.50	11.50	---
	>6.00		47.99	16.00	30.40	---	---	15.00
	1.00 – 3.00	3.00	48.03	15.93	22.94	14.00	14.00	---
	3.00 – 6.00		47.87	16.08	25.73	14.00	15.00	---
	>6.00		59.49	19.83	35.69	---	---	18.00
	1.00 – 3.00	4.00	68.47	22.82	32.86	14.50	18.00	---
	3.00 – 6.00		61.93	20.64	29.72	16.00	20.00	---
	>6.00		71.49	23.83	40.51	---	---	22.00
	1.00 – 3.00	5.00	89.45	29.82	42.94	15.00	22.00	---
	3.00 – 6.00		77.09	25.70	37.01	16.50	22.00	---
	>6.00		84.00	28.00	47.60	---	---	23.00
	1.00 – 3.00	6.00	114.98	38.33	55.20	16.00	24.00	---
	3.00 – 6.00		92.87	30.96	46.81	16.50	23.00	---
	>6.00		97.01	32.34	51.74	---	---	25.00

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Location	Foundation Width (m)	Depth of Foundation below EGL (m)	Net Ultimate Bearing Capacity (t/m^2)	Net Safe Bearing Capacity (t/m^2)	Anticipated Settlement (mm)	Allowable Bearing Capacity for 25 mm settlement (t/m^2)	Allowable Bearing Capacity for 40 mm settlement (t/m^2)	Allowable Bearing Capacity for 75 mm settlement (t/m^2)
BH – 12	1.00 – 3.00	2.00	30.85	10.28	14.80	10.00	10.00	---
	3.00 – 6.00		35.11	11.70	19.89	11.50	11.50	---
	>6.00		47.99	16.00	30.40	---	---	15.00
	1.00 – 3.00	3.00	48.03	15.93	22.94	14.00	14.00	---
	3.00 – 6.00		47.87	16.08	25.73	14.00	15.00	---
	>6.00		59.49	19.83	35.69	---	---	18.00
	1.00 – 3.00	4.00	68.47	22.82	32.86	14.50	18.00	---
	3.00 – 6.00		61.93	20.64	29.72	16.00	20.00	---
	>6.00		71.49	23.83	40.51	---	---	22.00
	1.00 – 3.00	5.00	89.45	29.82	42.94	15.00	22.00	---
	3.00 – 6.00		77.09	25.70	37.01	16.50	22.00	---
	>6.00		84.00	28.00	47.60	---	---	23.00
	1.00 – 3.00	6.00	114.98	38.33	55.20	16.00	24.00	---
	3.00 – 6.00		92.87	30.96	46.81	16.50	23.00	---
	>6.00		97.01	32.34	51.74	---	---	25.00
BH – 13	1.00 – 3.00	5.00	89.45	29.82	42.94	15.00	22.00	---
	3.00 – 6.00		76.51	25.50	38.25	16.50	24.00	---
	>6.00		84.00	28.00	47.60	---	---	25.00
	1.00 – 3.00	6.00	114.98	38.33	55.20	17.00	25.00	---
	3.00 – 6.00		128.02	42.67	55.30	18.00	26.00	---
	>6.00		135.19	45.06	72.10	---	---	28.00
BH – 14	1.00 – 3.00	3.00	65.96	21.99	23.75	20.00	20.00	---
	3.00 – 6.00		66.67	22.22	33.33	15.00	20.00	---
	>6.00		83.49	27.83	40.08	---	---	24.00
	1.00 – 3.00	4.00	147.31	49.10	42.42	23.00	26.00	---
	3.00 – 6.00		135.14	45.05	48.65	20.00	27.00	---
	>6.00		157.01	52.34	64.06	---	---	27.00
	1.00 – 3.00	5.00	197.82	65.94	56.97	24.00	27.00	---
	3.00 – 6.00		167.42	55.81	60.27	21.00	28.00	---
	>6.00		183.69	61.23	74.95	---	---	28.00
	1.00 – 3.00	6.00	255.11	85.04	73.47	25.00	28.00	---
	3.00 – 6.00		201.41	67.14	72.51	22.00	29.00	---
	>6.00		211.55	70.52	81.24	---	---	30.00

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BH – 15	1.00 – 3.00	2.00	30.85	10.28	14.80	10.00	10.00	---
	3.00 – 6.00		35.11	11.70	19.89	11.50	11.50	---
	>6.00		47.99	16.00	30.40	---	---	15.00
	1.00 – 3.00	3.00	65.96	21.99	23.75	20.00	20.00	---
	3.00 – 6.00		66.67	22.22	33.33	15.00	20.00	---
	>6.00		83.49	27.83	40.08	---	---	24.00
	1.00 – 3.00	4.00	147.31	49.10	42.42	23.00	26.00	---
	3.00 – 6.00		135.14	45.05	48.65	20.00	27.00	---
	>6.00		157.01	52.34	64.06	---	---	27.00
	1.00 – 3.00	5.00	197.82	65.94	56.97	24.00	27.00	---
	3.00 – 6.00		167.42	55.81	60.27	21.00	28.00	---
	>6.00		183.69	61.23	74.95	---	---	28.00
	1.00 – 3.00	6.00	255.11	85.04	73.47	25.00	28.00	---
	3.00 – 6.00		201.41	67.14	72.51	22.00	29.00	---
	>6.00		211.55	70.52	81.24	---	---	30.00
BH – 16	1.00 – 3.00	2.00	30.85	10.28	14.80	10.00	10.00	---
	3.00 – 6.00		35.11	11.70	19.89	11.50	11.50	---
	>6.00		47.99	16.00	30.40	---	---	15.00
	1.00 – 3.00	3.00	48.03	15.93	22.94	14.00	14.00	---
	3.00 – 6.00		47.87	16.08	25.73	14.00	15.00	---
	>6.00		59.49	19.83	35.69	---	---	18.00
	1.00 – 3.00	4.00	68.47	22.82	32.86	14.50	18.00	---
	3.00 – 6.00		61.93	20.64	29.72	16.00	20.00	---
	>6.00		71.49	23.83	40.51	---	---	22.00
	1.00 – 3.00	5.00	89.45	29.82	42.94	15.00	22.00	---
	3.00 – 6.00		76.51	25.50	38.25	16.50	24.00	---
	>6.00		84.00	28.00	47.60	---	---	25.00
	1.00 – 3.00	6.00	114.98	38.33	55.20	17.00	25.00	---
	3.00 – 6.00		128.02	42.67	55.30	18.00	26.00	---
	>6.00		135.19	45.06	72.10	---	---	28.00

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Location	Foundation Width (m)	Depth of Foundation below EGL (m)	Net Ultimate Bearing Capacity (t/m^2)	Net Safe Bearing Capacity (t/m^2)	Anticipated Settlement (mm)	Allowable Bearing Capacity for 25 mm settlement (t/m^2)	Allowable Bearing Capacity for 40 mm settlement (t/m^2)	Allowable Bearing Capacity for 75 mm settlement (t/m^2)
BH – 17	1.00 – 3.00	3.00	48.03	15.93	22.94	14.00	14.00	---
	3.00 – 6.00		47.87	16.08	25.73	14.00	15.00	---
	>6.00		59.49	19.83	35.69	---	---	18.00
	1.00 – 3.00	4.00	93.66	31.22	33.72	20.00	25.00	---
	3.00 – 6.00		86.14	28.71	41.34	16.00	25.00	---
	>6.00		100.00	33.33	45.33	---	---	26.00
	1.00 – 3.00	5.00	197.82	65.94	56.97	24.00	27.00	---
	3.00 – 6.00		167.42	55.81	60.27	21.00	28.00	---
	>6.00		183.69	61.23	74.95	---	---	28.00
	1.00 – 3.00	6.00	255.11	85.04	73.47	25.00	28.00	---
	3.00 – 6.00		201.41	67.14	72.51	22.00	29.00	---
	>6.00		211.55	70.52	81.24	---	---	30.00
BH – 18	1.00 – 3.00	3.00	48.03	15.93	22.94	14.00	14.00	---
	3.00 – 6.00		47.87	16.08	25.73	14.00	15.00	---
	>6.00		59.49	19.83	35.69	---	---	18.00
	1.00 – 3.00	4.00	93.66	31.22	33.72	20.00	25.00	---
	3.00 – 6.00		86.14	28.71	41.34	16.00	25.00	---
	>6.00		100.00	33.33	45.33	---	---	26.00
	1.00 – 3.00	5.00	197.82	65.94	56.97	24.00	27.00	---
	3.00 – 6.00		167.42	55.81	60.27	21.00	28.00	---
	>6.00		183.69	61.23	74.95	---	---	28.00
	1.00 – 3.00	6.00	255.11	85.04	73.47	25.00	28.00	---
	3.00 – 6.00		201.41	67.14	72.51	22.00	29.00	---
	>6.00		211.55	70.52	81.24	---	---	30.00
BH – 21	1.00 – 3.00	2.00	30.85	10.28	14.80	10.00	10.00	---
	3.00 – 6.00		35.11	11.70	19.89	11.50	11.50	---
	>6.00		47.99	16.00	30.40	---	---	15.00
	1.00 – 3.00	3.00	48.03	15.93	22.94	14.00	14.00	---
	3.00 – 6.00		47.87	16.08	25.73	14.00	15.00	---
	>6.00		59.49	19.83	35.69	---	---	18.00
	1.00 – 3.00	4.00	68.47	22.82	32.86	14.50	18.00	---
	3.00 – 6.00		61.93	20.64	29.72	16.00	20.00	---
	>6.00		71.49	23.83	40.51	---	---	22.00



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Location	Foundation Width (m)	Depth of Foundation below EGL (m)	Net Ultimate Bearing Capacity (t/m^2)	Net Safe Bearing Capacity (t/m^2)	Anticipated Settlement (mm)	Allowable Bearing Capacity for 25 mm settlement (t/m^2)	Allowable Bearing Capacity for 40 mm settlement (t/m^2)	Allowable Bearing Capacity for 75 mm settlement (t/m^2)
BH – 21	1.00 – 3.00	5.00	89.45	29.82	42.94	15.00	22.00	---
	3.00 – 6.00		77.09	25.70	37.01	16.50	22.00	---
	>6.00		84.00	28.00	47.60	---	---	23.00
	1.00 – 3.00	6.00	114.98	38.33	55.20	16.00	24.00	---
	3.00 – 6.00		92.87	30.96	46.81	16.50	23.00	---
	>6.00		97.01	32.34	51.74	---	---	25.00
BH – 22	1.00 – 3.00	2.00	9.17	3.06	50.16	1.50	2.00	---
	3.00 – 6.00		9.05	3.02	65.55	1.00	1.50	---
	>6.00		8.64	2.88	71.29	---	---	2.50
	1.00 – 3.00	3.00	9.71	3.24	43.94	1.50	2.50	---
	3.00 – 6.00		8.91	2.97	68.08	1.00	1.50	---
	>6.00		8.70	2.90	62.91	---	---	2.50
	1.00 – 3.00	4.00	10.25	3.42	40.14	1.50	3.00	---
	3.00 – 6.00		9.17	3.06	60.13	1.00	2.00	---
	>6.00		8.91	2.97	55.63	---	---	2.50
	1.00 – 3.00	5.00	10.79	3.60	30.98	2.50	3.50	---
	3.00 – 6.00		9.44	3.15	46.88	1.50	2.50	---
	>6.00		9.11	3.04	46.54	---	---	3.00
	1.00 – 3.00	6.00	66.63	22.21	19.19	20.00	20.00	---
	3.00 – 6.00		78.04	26.01	28.09	22.00	25.00	---
	>6.00		107.15	35.72	41.15	---	---	28.00
BH – 23	1.00 – 3.00	3.00	65.96	21.99	23.75	20.00	20.00	---
	3.00 – 6.00		66.67	22.22	33.33	15.00	20.00	---
	>6.00		83.49	27.83	40.08	---	---	24.00
	1.00 – 3.00	4.00	147.31	49.10	42.42	23.00	26.00	---
	3.00 – 6.00		135.14	45.05	48.65	20.00	27.00	---
	>6.00		157.01	52.34	64.05	---	---	27.00
	1.00 – 3.00	5.00	197.82	65.94	56.97	24.00	27.00	---
	3.00 – 6.00		167.42	55.81	60.27	21.00	28.00	---
	>6.00		183.69	61.23	74.95	---	---	28.00
	1.00 – 3.00	6.00	255.11	85.04	73.47	25.00	28.00	---
	3.00 – 6.00		201.41	67.14	72.51	22.00	29.00	---
	>6.00		211.55	70.52	81.24	---	---	30.00



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Location	Foundation Width (m)	Depth of Foundation below EGL (m)	Net Ultimate Bearing Capacity (t/m ²)	Net Safe Bearing Capacity (t/m ²)	Anticipated Settlement (mm)	Allowable Bearing Capacity for 25 mm settlement (t/m ²)	Allowable Bearing Capacity for 40 mm settlement (t/m ²)	Allowable Bearing Capacity for 75 mm settlement (t/m ²)
BH – 24	1.00 – 3.00	2.00	30.85	10.28	14.80	10.00	10.00	---
	3.00 – 6.00		35.11	11.70	19.89	11.50	11.50	---
	>6.00		47.99	16.00	30.40	---	---	15.00
	1.00 – 3.00	3.00	48.03	15.93	22.94	14.00	14.00	---
	3.00 – 6.00		47.87	16.08	25.73	14.00	15.00	---
	>6.00		59.49	19.83	35.69	---	--	18.00
	1.00 – 3.00	4.00	68.47	22.82	32.86	14.50	18.00	---
	3.00 – 6.00		61.93	20.64	29.72	16.00	20.00	--
	>6.00		71.49	23.83	40.51	---	---	22.00
	1.00 – 3.00	5.00	89.45	29.82	42.94	15.00	22.00	---
	3.00 – 6.00		77.09	25.70	37.01	16.50	22.00	---
	>6.00		84.00	28.00	47.60	---	---	23.00
	1.00 – 3.00	6.00	114.98	38.33	55.20	16.00	24.00	---
	3.00 – 6.00		92.87	30.96	46.81	16.50	23.00	---
	>6.00		97.01	32.34	51.74	---	---	25.00
BH – 25	1.00 – 3.00	5.00	197.82	65.94	56.97	24.00	27.00	---
	3.00 – 6.00		167.42	55.81	60.27	21.00	28.00	---
	>6.00		183.69	61.23	74.95	---	---	28.00
	1.00 – 3.00	6.00	255.11	85.04	73.47	25.00	28.00	---
	3.00 – 6.00		201.41	67.14	72.51	22.00	29.00	---
	>6.00		211.55	70.52	81.24	---	---	30.00

Note: EGL means Existing Ground Level.

**** Stone column / Pile foundation is recommended for this borehole location. Due to higher depth of liquefaction zone open foundation is not recommended for this borehole location. Recommendation of stone column has been presented in Annexure – X.**

Sample computation of safe bearing capacity has been presented in annexure – VII.

Sample computation of settlement has been presented in annexure – VIII.

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4.7 Deep Foundation

Pile foundation should be considered for this type of structure. Bored cast in-situ piles are recommended due to existing subsoil conditions, availability of construction agencies and ease of construction. Ultimate vertical capacity of bored cast in situ RCC pile in soil may be estimated using the formula given below as per IS: 2911(Part II/ Sec 2).

$$Q_u = (A_p \times P_D \times N_q) + (A_p \times N_c \times C_p) + \sum [K_i \times P_{Di} \times \tan \delta_i \times A_{si}] + \sum [\alpha_i \times c_i \times A_{si}]$$

where,

Q_u = Ultimate vertical load carrying capacity of RCC bored pile,

A_p = Cross sectional area of pile tip. = $\pi/4 \times (D)^2$

D = Diameter of pile.

P_D = Effective overburden pressure at pile tip.

N_q = Bearing capacity factor for bored pile depending on Φ .

N_c = Bearing capacity factor, may be taken as 9.

C_p = Average cohesion at pile tip.

K_i = Co-efficient of earth pressure in i^{th} layer.

P_{Di} = Effective overburden pressure at the mid-depth of i^{th} layer.

Δ_i = Angle of wall friction between pile and soil for the i^{th} layer.

A_{si} = Surface area of pile shaft in i^{th} layer = $\pi \times D \times L_i$

L_i = Length of pile in respective stratum,

Φ = Angle of internal friction of soil.

A_i = Adhesion factor for the i^{th} layer.

C_i = Average cohesion for the i^{th} layer.

Safe pile capacities have also been estimated as above and recommended capacities are presented in table.

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BH. No.	Pile Dia. (mm)	Pile Depth below EGL (m)	Vertical Shaft Length (m)	Recommended Pile Capacities				Length of Fixity (m)
				Vertical (t)	Tensile (t)	Lateral (t)	Moment (t-m/ t of thrust)	
BH – 1	600	*20.00	18.00	100	38	3.75	3.58	4.68
	760			160	58	6.15	4.03	5.72
	1000			248	80	10.70	4.64	7.21
BH – 3	600	*20.00	18.00	115	52	8.45	2.04	4.97
	760			185	80	12.35	2.47	6.01
	1000			295	120	19.20	3.07	7.48
BH – 4	600	*20.00	18.00	85	28	2.75	4.33	4.60
	760			140	42	4.70	4.79	5.59
	1000			220	60	8.55	5.37	7.05
BH – 5	600	*20.00	18.00	72	30	3.75	3.58	4.68
	760			125	46	6.15	4.03	5.72
	1000			215	65	10.70	4.64	7.21
BH – 6	600	*20.00	18.00	115	50	8.45	2.04	4.97
	760			185	80	12.35	2.47	6.01
	1000			295	120	19.20	3.07	7.48
BH – 7	600	*20.00	18.00	120	54	8.45	2.04	4.97
	760			190	82	12.35	2.47	6.01
	1000			300	122	19.20	3.07	7.48
BH – 8	600	*20.00	18.00	75	30	3.75	3.58	4.68
	760			125	47	6.15	4.03	5.72
	1000			215	58	10.70	4.64	7.21
BH – 9	600	*20.00	18.00	72	30	3.75	3.58	4.68
	760			125	46	6.15	4.03	5.72
	1000			215	65	10.70	4.64	7.21
BH – 10	600	*20.00	18.00	90	44	8.95	2.00	4.88
	760			150	68	13.10	2.42	5.90
	1000			272	100	20.30	3.01	7.34
BH – 11	600	*20.00	18.00	60	32	7.60	2.11	5.16
	760			102	50	11.11	2.55	6.23
	1000			192	75	17.25	3.18	7.76

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BH. No.	Pile Dia. (mm)	Pile Depth below EGL (m)	Vertical Shaft Length (m)	Recommended Pile Capacities				Length of Fixity (m)
				Vertical (t)	Tensile (t)	Lateral (t)	Moment (t-m/ t of thrust)	
BH – 12	600	*20.00	18.00	75	30	8.45	2.04	4.97
	760			125	48	12.35	2.47	6.01
	1000			225	72	19.20	3.07	7.48
BH – 13	600	*20.00	18.00	80	35	5.30	2.84	4.86
	760			135	55	8.25	3.28	5.91
	1000			245	80	13.75	3.90	7.39
BH – 14	600	*20.00	18.00	115	51	8.95	2.00	4.88
	760			185	78	13.10	2.42	5.90
	1000			295	117	20.30	3.01	7.34
BH – 15	600	*20.00	18.00	90	43	8.95	2.00	4.88
	760			150	66	13.10	2.42	5.90
	1000			272	100	20.30	3.01	7.34
BH – 16	600	*20.00	18.00	85	40	7.60	2.11	5.16
	760			142	62	11.11	2.55	6.23
	1000			265	93	17.25	3.18	7.76
BH – 17	600	*20.00	18.00	112	48	7.90	2.08	5.08
	760			180	75	11.60	2.52	6.14
	1000			288	115	18.00	3.14	7.65
BH – 18	600	*20.00	18.00	105	45	7.90	2.08	5.08
	760			175	70	11.60	2.52	6.14
	1000			272	100	18.00	3.14	7.65
BH – 21	600	*20.00	18.00	85	40	8.45	2.04	4.97
	760			145	63	12.35	2.47	6.01
	1000			265	95	19.20	3.07	7.48
BH – 22	600	*20.00	18.00	118	52	3.00	2.38	6.79
	760			190	80	3.80	3.01	8.60
	1000			298	120	5.00	3.96	11.32
BH – 23	600	*20.00	18.00	120	55	8.45	2.04	4.97
	760			190	85	12.35	2.47	6.01
	1000			300	122	19.20	3.07	7.48



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BH. No.	Pile Dia. (mm)	Pile Depth below EGL (m)	Vertical Shaft Length (m)	Recommended Pile Capacities				Length of Fixity (m)
				Vertical (t)	Tensile (t)	Lateral (t)	Moment (t-m/ t of thrust)	
BH – 24	600	*20.00	18.00	82	40	7.60	2.11	5.16
	760			140	60	11.11	2.55	6.23
	1000			260	90	17.25	3.18	7.76
BH – 25	600	*20.00	18.00	100	40	5.80	2.76	4.68
	760			165	60	9.10	3.19	5.69
	1000			255	90	15.20	3.79	7.12

*Note: The above pile capacity values should be confirmed by suitable pile load test as per IS: 2911 (Part 4). Grade of Concrete = M30. * Assuming same soil stratum found at the termination depth of the borehole, continues from the pile end depth and to the minimum cushion depth criteria as per Cl .No. 4.1.a of IS 2911 (Part – 1/Sec 2) : 2010. Cut-off depth = 2.00 m below EGL.*

Sample computation of pile capacity has been presented in annexure – IX.

4.8 Conclusion and General Recommendations

Based on the field tests and the foregoing discussion the following are summarized:

- The subsoil is characterized by a layer of medium dense, silty sand layer at top followed by a decomposed sedimentary rock. After that a layer of weathered sedimentary rock layer is observed and that continues up to terminating depth of the boreholes.
- The present report deals with the geotechnical investigation findings at the location and the discussion on both the aspects regarding bearing capacity of open foundations and pile capacity for deep foundation in the form of bored cast in-situ pile depending on the field and laboratory test results.
- Standing water level was found with in 0.00 m to 0.40 m below existing ground level. However, ground water level is considered at ground level for design purpose.
- Determination of recommended safe bearing capacities of open/shallow foundation and safe capacities of deep foundations have been discussed in the section 4.6 & 4.7 However, bearing capacity values depend on foundation size, shape and depth.

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- e) Open foundations should not be placed over filled up soil.
- f) Open foundations should be placed in such a way that pressure bulb of each foundation must not overlap.
- g) Any loose/soft pocket of soil or expansive soil if found should be replaced.
- h) The structural designer may consider adoption of suitable diameter and length of pile foundation depending on the type size and other considerations of the proposed structure. For other diameter and length of pile, the load capacity may be estimated, using the same procedure as adopted in sample calculation as provided in this report. The type of foundations shall be adopted based on possible construction conditions.
- i) Precaution in all respect should be taken for nearby existing structures, if any.
- j) However, the structural designer/engineer concerned may take the final decision regarding foundation and may modulate the type of foundations and other values regarding foundation geometry and soil design parameter to meet any specific design criteria.
- k) The pile capacity values should be confirmed by suitable pile load test as per IS: 2911(Part 4).
- l) Further the pile should have necessary structural strength to transmit / sustain the design load.
- j) All the recommendations are entirely based on and limited to field data as obtained during investigation and laboratory tests conducted on soil samples as collected.

Report Prepared By: -

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Annexure I
Borehole Location

SL. NO.	BH NO.	CO-ORDINATE		Elevation in RL (m)
		Easting	Northing	
1	BH - 1	E 593060.00	N 755320.00	7.727
2	BH - 3	E 593100.00	N 755200.00	7.280
3	BH - 4	E 593200.00	N 755180.00	5.506
4	BH - 5	E 593220.00	N 755120.00	5.324
5	BH - 6	E 593160.00	N 755040.00	5.904
6	BH - 7	E 593020.00	N 754980.00	44.406
7	BH - 8	E 593260.00	N 755060.00	5.284
8	BH - 9	E 593510.00	N 754974.00	5.146
9	BH - 10	E 593500.00	N 754860.00	5.528
10	BH - 11	E 593570.00	N 754870.00	5.443
11	BH - 12	E 593530.00	N 754890.00	5.587
12	BH - 13	E 593560.00	N 754920.00	5.380
13	BH - 14	E 593510.00	N 754810.00	5.413
14	BH - 15	E 593560.00	N 754760.00	5.138
15	BH - 16	E 593469.00	N 754889.00	5.335
16	BH - 17	E 593270.00	N 754860.00	5.487
17	BH - 18	E 593330.00	N 754840.00	5.403
18	BH - 21	E 593410.00	N 754710.00	5.296
19	BH - 22	E 593220.00	N 755020.00	5.367
20	BH - 23	E 593240.00	N 754900.00	5.479
21	BH - 24	E 593280.00	N 754740.00	5.954
22	BH - 25	E 593140.00	N 754660.00	8.983

Annexure II
Borehole Log

Borehole No. BH - 1
Location Galathea, Great Nicobar
Co-ordinate E 593060.00, N 755320.00
R.L. (m) 7.727

Borehole Depth 20.00 m
Water Table 0.00 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, loose to medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	3,4,5 (9)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	5,5,6 (11)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	8,8,11 (19)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.05	SPT	59 blows / 5 cm ®	---	---	---	6.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.59	SPT	52 blows / 9 cm ®	---	---	---				
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.08	SPT	56 blows / 8 cm ®	---	---	---				
19	9.08-10.50	Core	---	0.36	25.35	Nil	9.50	Brownish grey, moderately to partially weathered sedimentary rock (Shale/siltstone).		
20	10.50-12.00	Core	---	0.41	27.33	Nil				
21	12.00-13.50	Core	---	0.51	34.00	18.66				
22	13.50-15.00	Core	---	0.55	36.67	Nil				
23	15.00-16.50	Core	---	0.52	34.67	26.66				
24	16.50-18.00	Core	---	0.42	28.00	Nil				
25	18.00-19.50	Core	---	0.45	30.00	16.66				
26	19.50-20.00	Core	---	0.16	32.00	Nil	20.00			

DS = Disturbed Sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 03
Location Galathea, Great Nicobar
Co-ordinate E 593100.00, N 755200.00
R.L. (m) 7.280

Borehole Depth 25.00 m
Water Table 0.40 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---	3.00			
3	1.50-1.95	SPT	3,4,6 (10)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.23	SPT	42,47 blows / 8 cm ®	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.55	SPT	59 blows / 5 cm ®	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.09	SPT	53 blows / 9 cm ®	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.60	SPT	52 blows / 10 cm ®	---	---	---				
16	7.60-9.00	Core	---	0.15	10.71	Nil	8.00			
17	9.00-9.08	SPT	56 blows / 8 cm ®	---	---	---				
18	9.50-10.00	DS	---	---	---	---				
19	10.00-10.50	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.56	SPT	54 blows / 6 cm ®	---	---	---				
22	10.56-12.00	Core	---	0.17	11.81	Nil				
23	12.00-12.09	SPT	51 blows / 9 cm ®	---	---	---				
24	12.09-13.50	Core	---	0.11	7.80	Nil				
25	13.50-13.61	SPT	57 blows / 11 cm ®	---	---	---				
26	14.00-14.50	DS	---	---	---	---				
27	14.50-15.00	DS	---	---	---	---				
28	15.00-15.05	SPT	67 blows / 5 cm ®	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

Annexure II
Borehole Log

Borehole No. BH - 03
 Location Galathea, Great Nicobar
 Co-ordinate E 593100.00, N 755200.00
 R.L. (m) 7.280

Borehole Depth 25.00 m
 Water Table 0.40 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
29	15.05-16.50	Core	---	0.31	21.38	Nil	15.50	Brownish grey, moderately to partially weathered sedimentary rock (Shale/siltstone).	Nil	Grey
30	16.50-18.00	Core	---	0.39	26.00	18.66				
31	18.00-19.50	Core	---	0.35	23.33	Nil				
32	19.50-21.00	Core	---	0.42	28.00	24.66				
33	21.00-22.50	Core	---	0.48	32.00	25.33				
34	22.50-24.00	Core	---	0.32	21.33	Nil				
35	24.00-25.00	Core	---	0.22	22.00	Nil	25.00			

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 04
 Location Galathea, Great Nicobar
 Co-ordinate E 593200.00, N 755180.00
 R.L. (m) 5.506

Borehole Depth 20.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	---	---	---	---				
3	1.50-1.95	SPT	3,5,8 (13)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	4,6,9 (15)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	2,3,7 (10)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	4,7,10 (17)	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	10,20,28 (48)	---	---	---	7.50	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.45	SPT	17,29,43 (72)	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.73	SPT	35,53 blows / 8 cm ®	---	---	---				
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.10	SPT	57 blows / 10 cm ®	---	---	---				
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.62	SPT	52 blows / 12 cm ®	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

Annexure II
Borehole Log

Borehole No. BH - 04
 Location Galathea, Great Nicobar
 Co-ordinate E 593200.00, N 755180.00
 R.L. (m) 5.506

Borehole Depth 20.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.00-15.07	SPT	54 blows / 7 cm ®	---	---	---	15.50	Brownish grey, moderately to partially weathered sedimentary rock (Shale/siltstone).	Nil	Grey
31	15.07-16.50	Core	---	0.31	21.68	Nil				
32	16.50-18.00	Core	---	0.43	28.67	Nil				
33	18.00-19.50	Core	---	0.48	32.00	Nil				
34	19.50-20.00	Core	---	0.16	32.00	Nil	20.00			

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

Annexure II
Borehole Log

Borehole No. BH - 05
 Location Galathea, Great Nicobar
 Co-ordinate E 593220.00, N 755120.00
 R.L. (m) 5.324

Borehole Depth 25.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, loose to medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	4,4,5 (9)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	4,4,7 (11)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	5,7,11 (18)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	9,11,13 (24)	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.72	SPT	39,56 blows / 7 cm ®	---	---	---	7.50	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.13	SPT	53 blows / 13 cm ®	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.60	SPT	58 blows / 10 cm ®	---	---	---				
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.14	SPT	61 blows / 14 cm ®	---	---	---				
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.95	SPT	13,23,32 (55)	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

Annexure II
Borehole Log

Borehole No. BH - 05
 Location Galathea, Great Nicobar
 Co-ordinate E 593220.00, N 755120.00
 R.L. (m) 5.324

Borehole Depth 25.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.00-15.45	SPT	16,21,37 (58)	---	---	---	25.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
31	15.50-16.00	DS	---	---	---	---				
32	16.00-16.50	DS	---	---	---	---				
33	16.50-16.95	SPT	18,25,39 (64)	---	---	---				
34	17.00-17.50	DS	---	---	---	---				
35	17.50-18.00	DS	---	---	---	---				
36	18.00-18.23	SPT	48,63 blows / 8 cm ®	---	---	---				
37	18.50-19.00	DS	---	---	---	---				
38	19.00-19.50	DS	---	---	---	---				
39	19.50-19.65	SPT	57 blows / 15 cm ®	---	---	---				
40	20.00-20.50	DS	---	---	---	---				
41	20.50-21.00	DS	---	---	---	---				
42	21.00-21.13	SPT	68 blows / 13 cm ®	---	---	---				
43	21.50-22.00	DS	---	---	---	---				
44	22.00-22.50	DS	---	---	---	---				
45	22.50-22.64	SPT	59 blows / 14 cm ®	---	---	---				
46	23.00-23.50	DS	---	---	---	---				
47	23.50-24.00	DS	---	---	---	---				
48	24.00-24.10	SPT	54 blows / 10 cm ®	---	---	---				
49	24.50-25.00	DS	---	---	---	---				
50	25.00-25.05	SPT	52 blows / 5 cm ®	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

Annexure II
Borehole Log

Borehole No. BH - 06
 Location Galathea, Great Nicobar
 Co-ordinate E 593160.00, N 755040.00
 R.L. (m) 5.904

Borehole Depth 20.00 m
 Water Table 0.32 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	3,5,8 (13)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.23	SPT	48,53 blows / 8 cm ®	---	---	---	3.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.57	SPT	59 blows / 7 cm ®	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.05	SPT	55 blows / 5 cm ®	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.57	SPT	54 blows / 7 cm ®	---	---	---				
16	7.57-9.00	Core	---	0.31	21.68	Nil	8.00	Brownish grey, moderately to partially weathered sedimentary rock (Shale/siltstone).		
17	9.00-10.50	Core	---	0.36	24.00	11.33				
18	10.50-12.00	Core	---	0.44	29.33	Nil				
19	12.00-13.50	Core	---	0.43	28.67	Nil				
20	13.50-15.00	Core	---	0.39	26.00	Nil				
21	15.00-16.50	Core	---	0.49	32.67	11.33				
22	16.50-18.00	Core	---	0.38	25.33	Nil				
23	18.00-19.50	Core	---	0.52	34.67	16.66				
24	19.50-20.00	Core	---	0.19	38.00	Nil	20.00			

DS = Disturbed Sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 07
 Location Galathea, Great Nicobar
 Co-ordinate E 593020.00, N 754980.00
 R.L. (m) 44.406

Borehole Depth 20.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, loose, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---	3.00			
3	1.50-1.95	SPT	3,3,5 (8)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.25	SPT	33,64 blows / 10 cm ®	---	---	---	5.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.57	SPT	57 blows / 7 cm ®	---	---	---				
10	4.57-6.00	Core	---	0.34	23.78	Nil	20.00	Brownish grey, moderately to partially weathered sedimentary rock (Shale/siltstone).		
11	6.00-7.50	Core	---	0.43	28.67	Nil				
12	7.50-9.00	Core	---	0.32	21.33	Nil				
13	9.00-10.50	Core	---	0.48	32.00	Nil				
14	10.50-12.00	Core	---	0.36	24.00	8.66				
15	12.00-13.50	Core	---	0.40	26.67	14.00				
16	13.50-15.00	Core	---	0.42	28.00	Nil				
17	15.00-16.50	Core	---	0.51	34.00	20.00				
18	16.50-18.00	Core	---	0.38	25.33	Nil				
19	18.00-19.50	Core	---	0.41	27.33	Nil				
20	19.50-20.00	Core	---	0.19	38.00	Nil				

DS = Disturbed Sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 08
 Location Galathea, Great Nicobar
 Co-ordinate E 593260.00, N 755060.00
 R.L. (m) 5.284

Borehole Depth 25.00 m
 Water Table 0.20 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	5,7,9 (16)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	4,8,13 (21)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	5,8,11 (19)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.22	SPT	38,54 blows / 7 cm ®	---	---	---	6.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.60	SPT	58 blows / 10 cm ®	---	---	---				
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.12	SPT	53 blows / 12 cm ®	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.59	SPT	51 blows / 9 cm ®	---	---	---				
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.10	SPT	65 blows / 10 cm ®	---	---	---				
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.63	SPT	56 blows / 13 cm ®	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 08
 Location Galathea, Great Nicobar
 Co-ordinate E 593260.00, N 755060.00
 R.L. (m) 5.284

Borehole Depth 25.00 m
 Water Table 0.20 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.00-15.11	SPT	58 blows / 11 cm ®	---	---	---	25.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
31	15.50-16.00	DS	---	---	---	---				
32	16.00-16.50	DS	---	---	---	---				
33	16.50-16.79	SPT	27,57 blows / 14 cm ®	---	---	---				
34	17.00-17.50	DS	---	---	---	---				
35	17.50-18.00	DS	---	---	---	---				
36	18.00-18.12	SPT	63 blows / 12 cm ®	---	---	---				
37	18.50-19.00	DS	---	---	---	---				
38	19.00-19.50	DS	---	---	---	---				
39	19.50-19.58	SPT	59 blows / 8 cm ®	---	---	---				
40	20.00-20.50	DS	---	---	---	---				
41	20.50-21.00	DS	---	---	---	---				
42	21.00-21.08	SPT	59 blows / 8 cm ®	---	---	---				
43	21.50-22.00	DS	---	---	---	---				
44	22.00-22.50	DS	---	---	---	---				
45	22.50-22.60	SPT	62 blows / 10 cm ®	---	---	---				
46	23.00-23.50	DS	---	---	---	---				
47	23.50-24.00	DS	---	---	---	---				
48	24.00-24.13	SPT	38,56 blows / 13 cm ®	---	---	---				
49	24.50-25.00	DS	---	---	---	---				
50	25.00-25.12	SPT	52 blows / 12 cm ®	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 09
 Location Galathea, Great Nicobar
 Co-ordinate E 593510.00, N 754974.00
 R.L. (m) 5.146

Borehole Depth 25.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, loose to medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	3,1,2 (3)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	2,4,5 (9)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	5,7,7 (14)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	7,9,13 (22)	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	11,15,19 (34)	---	---	---	7.50	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.45	SPT	14,18,19 (37)	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.95	SPT	15,16,21 (37)	---	---	---				
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.45	SPT	18,22,27 (49)	---	---	---				
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.95	SPT	19,21,23 (44)	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test.

Annexure II
Borehole Log

Borehole No. BH - 09
 Location Galathea, Great Nicobar
 Co-ordinate E 593510.00, N 754974.00
 R.L. (m) 5.146

Borehole Depth 25.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m) (m)		Water loss	Colour
30	15.00-15.45	SPT	17,24,24 (48)	---	---	---	25.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
31	15.50-16.00	DS	---	---	---	---				
32	16.00-16.50	DS	---	---	---	---				
33	16.50-16.95	SPT	18,21,24 (45)	---	---	---				
34	17.00-17.50	DS	---	---	---	---				
35	17.50-18.00	DS	---	---	---	---				
36	18.00-18.45	SPT	20,23,29 (52)	---	---	---				
37	18.50-19.00	DS	---	---	---	---				
38	19.00-19.50	DS	---	---	---	---				
39	19.50-19.95	SPT	17,20,25 (45)	---	---	---				
40	20.00-20.50	DS	---	---	---	---				
41	20.50-21.00	DS	---	---	---	---				
42	21.00-21.45	SPT	21,25,30 (55)	---	---	---				
43	21.50-22.00	DS	---	---	---	---				
44	22.00-22.50	DS	---	---	---	---				
45	22.50-22.95	SPT	20,27,35 (62)	---	---	---				
46	23.00-23.50	DS	---	---	---	---				
47	23.50-24.00	DS	---	---	---	---				
48	24.00-24.45	SPT	23,29,39 (68)	---	---	---				
49	24.50-25.00	DS	---	---	---	---				
50	25.00-25.45	SPT	27,34,45 (79)	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test.

**Annexure II
Borehole Log**

Borehole No. BH - 10
 Location Galathea, Great Nicobar
 Co-ordinate E 593500.00, N 754860.00
 R.L. (m) 5.528

Borehole Depth 25.00 m
 Water Table 0.20 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	9,13,20 (33)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	10,15,23 (38)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	11,14,20 (34)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	12,15,22 (37)	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	13,16,23 (39)	---	---	---				
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.45	SPT	14,17,24 (41)	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.95	SPT	15,18,25 (43)	---	---	---				
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.45	SPT	16,20,24 (44)	---	---	---				
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.95	SPT	15,19,23 (42)	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test.

**Annexure II
Borehole Log**

Borehole No. BH - 10
 Location Galathea, Great Nicobar
 Co-ordinate E 593500.00, N 754860.00
 R.L. (m) 5.528

Borehole Depth 25.00 m
 Water Table 0.20 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.00-15.45	SPT	17,21,25 (46)	---	---	---	25.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
31	15.50-16.00	DS	---	---	---	---				
32	16.00-16.50	DS	---	---	---	---				
33	16.50-16.95	SPT	16,22,26 (48)	---	---	---				
34	17.00-17.50	DS	---	---	---	---				
35	17.50-18.00	DS	---	---	---	---				
36	18.00-18.45	SPT	17,23,28 (51)	---	---	---				
37	18.50-19.00	DS	---	---	---	---				
38	19.00-19.50	DS	---	---	---	---				
39	19.50-19.95	SPT	18,22,27 (49)	---	---	---				
40	20.00-20.50	DS	---	---	---	---				
41	20.50-21.00	DS	---	---	---	---				
42	21.00-21.14	SPT	56 blows / 14 cm ®	---	---	---				
43	21.50-22.00	DS	---	---	---	---				
44	22.00-22.50	DS	---	---	---	---				
45	22.50-22.65	SPT	50 blows / 15 cm ®	---	---	---				
46	23.00-23.50	DS	---	---	---	---				
47	23.50-24.00	DS	---	---	---	---				
48	24.00-24.13	SPT	52 blows / 13 cm ®	---	---	---				
49	24.50-25.00	DS	---	---	---	---				
50	25.00-25.10	SPT	54 blows / 10 cm ®	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

Annexure II
Borehole Log

Borehole No. BH - 11
Location Galathea, Great Nicobar
Co-ordinate E 593570.00, N 754870.00
R.L. (m) 5.443

Borehole Depth 25.00 m
Water Table 0.30 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	8,11,17 (28)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	8,12,17 (29)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	8,17,30 (47)	---	---	---	4.50	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	9,19,35 (54)	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	9,19,35 (54)	---	---	---				
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.22	SPT	22,52 blows / 7 cm ®	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.72	SPT	23,52 blows / 7 cm ®	---	---	---				
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.45	SPT	4,8,12 (20)	---	---	---	12.00	Brownish grey, wet, medium dense, silty fine sand.		
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.95	SPT	6,8,14 (22)	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

Annexure II
Borehole Log

Borehole No. BH - 11
 Location Galathea, Great Nicobar
 Co-ordinate E 593570.00, N 754870.00
 R.L. (m) 5.443

Borehole Depth 25.00 m
 Water Table 0.30 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.00-15.45	SPT	6,8,13 (21)	---	---	---	21.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
31	15.50-16.00	DS	---	---	---	---				
32	16.00-16.50	DS	---	---	---	---				
33	16.50-16.95	SPT	8,8,17 (25)	---	---	---				
34	17.00-17.50	DS	---	---	---	---				
35	17.50-18.00	DS	---	---	---	---				
36	18.00-18.45	SPT	8,10,17 (27)	---	---	---				
37	18.50-19.00	DS	---	---	---	---				
38	19.00-19.50	DS	---	---	---	---				
39	19.50-19.95	SPT	9,9,19 (28)	---	---	---				
40	20.00-20.50	DS	---	---	---	---				
41	20.50-21.00	DS	---	---	---	---				
42	21.00-21.45	SPT	10,13,21 (34)	---	---	---		Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
43	21.50-22.00	DS	---	---	---	---				
44	22.00-22.50	DS	---	---	---	---				
45	22.50-22.95	SPT	11,15,20 (35)	---	---	---				
46	23.00-23.50	DS	---	---	---	---				
47	23.50-24.00	DS	---	---	---	---				
48	24.00-24.45	SPT	13,18,23 (41)	---	---	---				
49	24.50-25.00	DS	---	---	---	---				
50	25.00-25.45	SPT	14,17,22 (39)	---	---	---	25.00			

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 12
 Location Galathea, Great Nicobar
 Co-ordinate E 593530.00, N 754890.00
 R.L. (m) 5.587

Borehole Depth 25.00 m
 Water Table 0.40 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	8,12,18 (30)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	9,13,20 (33)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	11,14,22 (36)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	12,15,23 (38)	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	6,7,9 (16)	---	---	---	7.50	Brownish grey, wet, medium dense, silty fine sand.		
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.45	SPT	5,7,8 (15)	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.95	SPT	5,6,11 (17)	---	---	---				
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.45	SPT	4,5,13 (18)	---	---	---				
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.95	SPT	6,6,14 (20)	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test.

**Annexure II
Borehole Log**

Borehole No. BH - 12
Location Galathea, Great Nicobar
Co-ordinate E 593530.00, N 754890.00
R.L. (m) 5.587

Borehole Depth 25.00 m
Water Table 0.40 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m) (m)		Water loss	Colour
30	15.00-15.45	SPT	6,7,15 (22)	---	---	---	21.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
31	15.50-16.00	DS	---	---	---	---				
32	16.00-16.50	DS	---	---	---	---				
33	16.50-16.95	SPT	7,8,16 (24)	---	---	---				
34	17.00-17.50	DS	---	---	---	---				
35	17.50-18.00	DS	---	---	---	---				
36	18.00-18.45	SPT	8,9,17 (26)	---	---	---				
37	18.50-19.00	DS	---	---	---	---				
38	19.00-19.50	DS	---	---	---	---				
39	19.50-19.95	SPT	9,11,18 (29)	---	---	---				
40	20.00-20.50	DS	---	---	---	---				
41	20.50-21.00	DS	---	---	---	---				
42	21.00-21.45	SPT	11,13,20 (33)	---	---	---				
43	21.50-22.00	DS	---	---	---	---				
44	22.00-22.50	DS	---	---	---	---				
45	22.50-22.95	SPT	11,13,20 (33)	---	---	---				
46	23.00-23.50	DS	---	---	---	---				
47	23.50-24.00	DS	---	---	---	---				
48	24.00-24.45	SPT	14,16,22 (38)	---	---	---				
49	24.50-25.00	DS	---	---	---	---				
50	25.00-25.45	SPT	15,17,24 (41)	---	---	---	25.00			

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test.

**Annexure II
Borehole Log**

Borehole No. BH - 13
 Location Galathea, Great Nicobar
 Co-ordinate E 593560.00, N 754920.00
 R.L. (m) 5.38

Borehole Depth 25.00 m
 Water Table 0.20 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	4,5,8 (13)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	3,6,9 (15)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	9,10,11 (21)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	10,12,13 (25)	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	17,15,20 (35)	---	---	---	7.50	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.45	SPT	19,18,25 (43)	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.95	SPT	16,17,19 (36)	---	---	---				
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.45	SPT	15,16,18 (34)	---	---	---				
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.95	SPT	16,17,21 (38)	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test.

Annexure II
Borehole Log

Borehole No. BH - 13
Location Galathea, Great Nicobar
Co-ordinate E 593560.00, N 754920.00
R.L. (m) 5.38

Borehole Depth 25.00 m
Water Table 0.20 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.00-15.45	SPT	15,14,23 (37)	---	---	---	25.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
31	15.50-16.00	DS	---	---	---	---				
32	16.00-16.50	DS	---	---	---	---				
33	16.50-16.95	SPT	16,17,22 (39)	---	---	---				
34	17.00-17.50	DS	---	---	---	---				
35	17.50-18.00	DS	---	---	---	---				
36	18.00-18.45	SPT	17,18,23 (41)	---	---	---				
37	18.50-19.00	DS	---	---	---	---				
38	19.00-19.50	DS	---	---	---	---				
39	19.50-19.95	SPT	18,20,24 (44)	---	---	---				
40	20.00-20.50	DS	---	---	---	---				
41	20.50-21.00	DS	---	---	---	---				
42	21.00-21.45	SPT	19,22,26 (48)	---	---	---				
43	21.50-22.00	DS	---	---	---	---				
44	22.00-22.50	DS	---	---	---	---				
45	22.50-22.95	SPT	20,24,28 (52)	---	---	---				
46	23.00-23.50	DS	---	---	---	---				
47	23.50-24.00	DS	---	---	---	---				
48	24.00-24.45	SPT	22,26,30 (56)	---	---	---				
49	24.50-25.00	DS	---	---	---	---				
50	25.00-25.45	SPT	24,28,32 (60)	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test.

**Annexure II
Borehole Log**

Borehole No. BH - 14
Location Galathea, Great Nicobar
Co-ordinate E 593510.00, N 754810.00
R.L. (m) 5.413

Borehole Depth 25.00 m
Water Table 0.30 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---	3.00			
3	1.50-1.95	SPT	7,9,13 (22)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	8,13,18 (31)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	9,15,23 (38)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	9,18,27 (45)	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	8,15,24 (39)	---	---	---				
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.23	SPT	26,54 blows / 8 cm ®	---	---	---				
19	9.23-10.50	Core	---	0.38	29.92	12.00				
20	10.50-12.00	Core	---	0.13	8.67	Nil				
21	12.00-12.05	SPT	51 blows / 5 cm ®	---	---	---				
22	12.06-13.50	Core	---	0.33	22.92	Nil				
23	13.50-13.57	SPT	53 blows / 7 cm ®	---	---	---				
24	13.57-15.00	Core	---	0.22	15.38	Nil				
25	15.00-15.09	SPT	56 blows / 9 cm ®	---	---	---				
26	15.09-16.50	Core	---	0.24	17.02	Nil				
27	16.50-16.59	SPT	52 blows / 9 cm ®	---	---	---				
28	16.59-18.00	Core	---	0.21	14.89	Nil				
29	18.00-18.10	SPT	55 blows / 10 cm ®							

DS = Disturbed Sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 14
 Location Galathea, Great Nicobar
 Co-ordinate E 593510.00, N 754810.00
 R.L. (m) 5.413

Borehole Depth 25.00 m
 Water Table 0.30 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	18.10-19.50	Core	---	0.31	22.14	Nil	18.50	Brownish grey, moderately to partially weathered sedimentary rock (Shale/siltstone).	Nil	Grey
31	19.50-21.00	Core	---	0.37	24.67	Nil				
32	21.00-22.50	Core	---	0.33	22.00	Nil				
33	22.50-24.00	Core	---	0.32	21.33	Nil				
34	24.00-25.00	Core	---	0.24	24.00	Nil	25.00			

DS = Disturbed Sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 15
 Location Galathea, Great Nicobar
 Co-ordinate E 593560.00, N 754760.00
 R.L. (m) 5.138

Borehole Depth 25.00 m
 Water Table 0.20 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---	3.00			
3	1.50-1.95	SPT	8,10,15 (25)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	10,17,23 (40)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	10,21,28 (49)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	11,20,32 (52)	---	---	---	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).			
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	11,18,29 (47)	---	---	---				
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.45	SPT	5,5,8 (13)	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.61	SPT	51 blows / 11 cm ®	---	---	---		10.50		
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.09	SPT	53 blows / 9 cm ®	---	---	---				
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.95	SPT	8,13,23 (36)	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 15
 Location Galathea, Great Nicobar
 Co-ordinate E 593560.00, N 754760.00
 R.L. (m) 5.138

Borehole Depth 25.00 m
 Water Table 0.20 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.00-15.45	SPT	12,19,28 (47)	---	---	---	25.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
31	15.50-16.00	DS	---							
32	16.00-16.50	DS	---							
33	16.50-16.95	SPT	9,16,25 (41)	---	---	---				
34	17.00-17.50	DS	---							
35	17.50-18.00	DS	---							
36	18.00-18.45	SPT	13,24,33 (57)	---	---	---				
37	18.50-19.00	DS	---							
38	19.00-19.50	DS	---							
39	19.50-19.95	SPT	11,19,27 (46)	---	---	---				
40	20.00-20.50	DS	---							
41	20.50-21.00	DS	---							
42	21.00-21.45	SPT	9,17,28 (45)	---	---	---				
43	21.50-22.00	DS	---							
44	22.00-22.50	DS	---							
45	22.50-22.95	SPT	10,18,32 (50)	---	---	---				
46	23.00-23.50	DS	---							
47	23.50-24.00	DS	---							
48	24.00-24.45	SPT	10,22,31 (53)	---	---	---				
49	24.50-25.00	DS								
50	25.00-25.45	SPT	12,19,30 (49)	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 16
 Location Galathea, Great Nicobar
 Co-ordinate E 593469.00, N 754889.00
 R.L. (m) 5.335

Borehole Depth 25.00 m
 Water Table 0.20 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	9,15,20 (35)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	10,17,23 (40)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	8,11,13 (24)	---	---	---	4.50	Brownish grey, wet, medium dense, silty fine sand.		
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	9,12,15 (27)	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	12,14,16 (30)	---	---	---				
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.45	SPT	10,15,17 (32)	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.95	SPT	9,13,15 (28)	---	---	---				
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.45	SPT	12,13,18 (31)	---	---	---	12.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.95	SPT	14,16,18 (34)	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test.

Annexure II
Borehole Log

Borehole No. BH - 16
 Location Galathea, Great Nicobar
 Co-ordinate E 593469.00, N 754889.00
 R.L. (m) 5.335

Borehole Depth 25.00 m
 Water Table 0.20 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.00-15.45	SPT	15,17,19 (36)	---	---	---	25.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
31	15.50-16.00	DS	---	---	---	---				
32	16.00-16.50	DS	---	---	---	---				
33	16.50-16.95	SPT	16,17,18 (35)	---	---	---				
34	17.00-17.50	DS	---	---	---	---				
35	17.50-18.00	DS	---	---	---	---				
36	18.00-18.45	SPT	17,19,20 (39)	---	---	---				
37	18.50-19.00	DS	---	---	---	---				
38	19.00-19.50	DS	---	---	---	---				
39	19.50-19.95	SPT	18,20,21 (41)	---	---	---				
40	20.00-20.50	DS	---	---	---	---				
41	20.50-21.00	DS	---	---	---	---				
42	21.00-21.45	SPT	19,21,23 (44)	---	---	---				
43	21.50-22.00	DS	---	---	---	---				
44	22.00-22.50	DS	---	---	---	---				
45	22.50-22.95	SPT	20,22,24 (46)	---	---	---				
46	23.00-23.50	DS	---	---	---	---				
47	23.50-24.00	DS	---	---	---	---				
48	24.00-24.45	SPT	22,24,26 (50)	---	---	---				
49	24.50-25.00	DS	---	---	---	---				
50	25.00-25.45	SPT	23,25,28 (53)	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test.

**Annexure II
Borehole Log**

Borehole No. BH - 17
 Location Galathea, Great Nicobar
 Co-ordinate E 593270.00, N 754860.00
 R.L. (m) 5.487

Borehole Depth 25.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	7,8,11 (19)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	9,11,15 (26)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.60	SPT	51 blows / 10 cm ®	---	---	---	4.50	Brownish grey, wet, very dense, silty fine sand (Weathered sedimentary rock).		
10	4.60-6.00	Core	---	0.15	10.71	Nil				
11	6.00-6.12	SPT	54 blows / 12 cm ®	---	---	---				
12	6.12-7.50	Core	---	0.17	12.32	Nil				
13	7.50-7.57	SPT	60 blows / 7 cm ®	---	---	---				
14	7.57-9.00	Core	---	0.21	14.69	Nil				
15	9.00-9.11	SPT	53 blows / 11 cm ®	---	---	---				
16	9.11-10.50	Core	---	0.25	17.99	Nil				
17	10.50-10.55	SPT	55 blows / 5 cm ®	---	---	---	11.00	Brownish grey, moderately to partially weathered sedimentary rock (Shale/siltstone).		
18	10.55-12.00	Core	---	0.34	23.45	Nil				
19	12.00-12.06	SPT	51 blows / 6 cm ®	---	---	---				
20	12.06-13.50	Core	---	0.32	22.22	Nil				
21	13.50-13.52	SPT	51 blows / 2 cm ®	---	---	---				
22	13.52-15.00	Core	---	0.39	26.35	Nil				
23	15.00-16.50	Core	---	0.44	29.33	Nil				
24	16.50-18.00	Core	---	0.54	36.00	Nil				
25	18.00-19.50	Core	---	0.62	41.33	12.00				
26	19.50-21.00	Core	---	0.59	39.33	Nil				
27	21.00-22.50	Core	---	0.68	45.33	13.67				
28	22.50-24.00	Core	---	0.64	42.67	11.33				
29	24.00-25.00	Core	---	0.35	35.00	Nil	25.00			

DS = Disturbed Sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

Annexure II
Borehole Log

Borehole No. BH - 18
Location Galathea, Great Nicobar
Co-ordinate E 593330, N 754840.00
R.L. (m) 5.403

Borehole Depth 25.00 m
Water Table 0.00 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	6,7,9 (16)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	8,10,18 (25)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.64	SPT	51 blows / 14 cm ®	---	---	---	4.50	Brownish grey, wet, very dense, silty fine sand (Weathered sedimentary rock).		
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.09	SPT	62 blows / 9 cm ®	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.55	SPT	57 blows / 5 cm ®	---	---	---				
16	7.55-9.00	Core	---	0.17	11.72	Nil				
17	9.00-9.13	SPT	55 blows / 13 cm ®	---	---	---				
18	9.50-10.00	DS	---	---	---	---				
19	10.00-10.50	DS	---	---	---	---				
20	10.50-10.60	SPT	51 blows / 10 cm ®	---	---	---				
21	10.60-12.00	Core	---	0.21	15.00	Nil				
22	12.00-12.11	SPT	51 blows / 11 cm ®	---	---	---				
23	12.50-13.00	DS	---	---	---	---				
24	13.00-13.50	DS	---	---	---	---				
25	13.50-13.54	SPT	57 blows / 4 cm ®	---	---	---				
26	13.54-15.00	Core	---	0.23	15.75	Nil				
27	15.00-15.07	SPT	51 blows / 2 cm ®	---	---	---				

DS = Disturbed Sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

Annexure II Borehole Log

Borehole No. BH - 18
 Location Galathea, Great Nicobar
 Co-ordinate E 593330, N 754840.00
 R.L. (m) 5.403

Borehole Depth 25.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
28	15.07-16.50	Core	---	0.36	25.17	Nil	15.50	Brownish grey, moderately to partially weathered sedimentary rock (Shale/siltstone).	Nil	Grey
29	16.50-18.00	Core	---	0.57	38.00	Nil				
30	18.00-19.50	Core	---	0.64	42.67	13.33				
31	19.50-21.00	Core	---	0.61	40.67	Nil				
32	21.00-22.50	Core	---	0.69	46.00	14.00				
33	22.50-24.00	Core	---	0.63	42.00	12.00				
34	24.00-25.00	Core	---	0.34	34.00	Nil	25.00			

DS = Disturbed Sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

Annexure II
Borehole Log

Borehole No. BH - 21
Location Galathea, Great Nicobar
Co-ordinate E 593410.00, N 754710.00
R.L. (m) 5.296

Borehole Depth 20.00 m
Water Table 0.00 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	5,9,14 (23)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	11,18,23 (41)	---	---	---	3.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	10,16,20 (36)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---		Brownish grey, wet, medium dense, silty fine sand.		
12	6.00-6.45	SPT	9,12,13 (25)	---	---	---	6.00			
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	11,13,14 (27)	---	---	---				
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.45	SPT	7,10,13 (23)	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.90	SPT	28,38,52 blows/10cm®	---	---	---	10.50	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.23	SPT	48,57 blows / 8 cm ®	---	---	---				
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.63	SPT	59 blows / 13 cm ®	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 21
 Location Galathea, Great Nicobar
 Co-ordinate E 593410.00, N 754710.00
 R.L. (m) 5.296

Borehole Depth 20.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.00-15.45	SPT	12,18,29 (47)	---	---	---	20.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
31	15.50-16.00	DS	---	---	---	---				
32	16.00-16.50	DS	---	---	---	---				
33	16.50-16.95	SPT	14,19,31 (50)	---	---	---				
34	17.00-17.50	DS	---	---	---	---				
35	17.50-18.00	DS	---	---	---	---				
36	18.00-18.45	SPT	16,23,38 (61)	---	---	---				
37	18.50-19.00	DS	---	---	---	---				
38	19.00-20.00	DS	---	---	---	---				
39	19.50-19.95	SPT	59 blows / 13 cm ®	---	---	---				
40	20.00-20.45	SPT	60 blows / 13 cm ®	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 22
Location Galathea, Great Nicobar
Co-ordinate E 593220.00, N 755020.00
R.L. (m) 5.367

Borehole Depth 25.00 m
Water Table 0.00 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length	Recovery (%)	RQD (%)			Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, soft to very soft, clayey silt with sand and decomposed wood.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---	6.00			
3	1.50-1.95	SPT	1,1,1 (2)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	1,1,1 (2)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.40	UDS	---	---	---	---				
9	4.50-4.95	SPT	2,2,2 (4)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.10	SPT	52 blows / 10 cm ®	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.57	SPT	57 blows / 7 cm ®	---	---	---				
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.12	SPT	51 blows / 12 cm ®	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.60	SPT	55 blows / 10 cm ®	---	---	---				
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.08	SPT	61 blows / 8 cm ®	---	---	---				
25	12.08-13.50	Core	---	0.20	14.08	Nil				
26	13.50-13.57	SPT	54 blows / 7 cm ®	---	---	---				
27	14.00-14.50	DS	---	---	---	---				
28	14.50-15.00	DS	---	---	---	---				
29	15.00-15.11	SPT	59 blows / 11 cm ®	---	---	---				
								Brownish grey, wet, very dense, silty fine sand (Weathered sedimentary rock).		

DS = Disturbed Sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

Annexure II
Borehole Log

Borehole No. BH - 22
 Location Galathea, Great Nicobar
 Co-ordinate E 593220.00, N 755020.00
 R.L. (m) 5.367

Borehole Depth 25.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.50-16.00	DS	---				25.00	Brownish grey, wet, very dense, silty fine sand (Weathered sedimentary rock).	Nil	Grey
31	16.00-16.50	DS	---							
32	16.50-16.54	SPT	52 blows / 4 cm ®	---	---	---				
33	16.54-18.00	Core	---	0.25	17.12	Nil				
34	18.00-18.09	SPT	61 blows / 9 cm ®	---	---	---				
35	18.50-19.00	DS	---							
36	19.00-19.50	DS	---							
37	19.50-19.57	SPT	54 blows / 7 cm ®	---	---	---				
38	19.57-21.00	Core	---	0.19	13.29	Nil				
39	21.00-21.03	SPT	51 blows / 3 cm ®	---	---	---				
40	21.50-22.00	DS	---							
41	22.00-22.50	DS	---							
42	22.50-22.61	SPT	59 blows / 11 cm ®	---	---	---				
43	22.61-24.00	Core	---	0.26	18.71	Nil				
44	24.00-24.10	SPT	62 blows / 10 cm ®	---	---	---				
45	24.50-25.00	DS	---	---	---	---				
46	25.00-25.05	SPT	53 blows / 5 cm ®	---	---	---				

DS = Disturbed Sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

Annexure II Borehole Log

Borehole No. BH - 23
 Location Galathea, Great Nicobar
 Co-ordinate E 593240.00, N 754900.00
 R.L. (m) 5.479

Borehole Depth 25.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water		
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour	
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey	
2	1.00-1.40	UDS	(Slipped)	---	---	---					
3	1.50-1.95	SPT	4,5,5 (10)	---	---	---					
4	2.00-2.50	DS	---	---	---	---					
5	2.50-3.00	DS	---	---	---	---					
6	3.00-3.45	SPT	9,20,26 (46)	---	---	---	3.00	Brownish grey, wet, dense, silty fine sand (Decomposed sedimentary rock).			
7	3.50-4.00	DS	---	---	---	---					
8	4.00-4.50	DS	---	---	---	---					
9	4.50-4.64	SPT	53 blows / 14 cm ®	---	---	---	4.50	Brownish grey, wet, very dense, silty fine sand (Weathered sedimentary rock).			
10	5.00-5.50	DS	---	---	---	---					
11	5.50-6.00	DS	---	---	---	---					
12	6.00-6.10	SPT	56 blows / 10 cm ®	---	---	---					
13	6.10-7.50	Core	---	0.18	12.86	Nil					
14	7.50-7.62	SPT	54 blows / 12 cm ®	---	---	---					
15	7.62-9.00	Core	---	0.22	15.94	Nil					
16	9.00-9.12	SPT	51 blows / 12 cm ®	---	---	---					
17	9.12-10.50	Core	---	0.29	21.01	Nil	9.50				Brownish grey, moderately to partially weathered sedimentary rock (Shale/siltstone).
18	10.50-10.58	SPT	52 blows / 8 cm ®	---	---	---					
19	10.58-12.00	Core	---	0.33	23.24	Nil					
20	12.00-12.11	SPT	51 blows / 11 cm ®	---	---	---					
21	12.11-13.50	Core	---	0.35	25.18	Nil					
22	13.50-13.54	SPT	52 blows / 4 cm ®	---	---	---					
23	13.54-15.00	Core	---	0.38	26.03	Nil					
24	15.00-16.50	Core	---	0.43	28.67	Nil					
25	16.50-18.00	Core	---	0.57	38.00	Nil					
26	18.00-19.50	Core	---	0.61	40.67	Nil					
27	19.50-21.00	Core	---	0.65	43.33	13.33					
28	21.00-22.50	Core	---	0.53	35.33	Nil					
29	22.50-24.00	Core	---	0.62	41.33	10.00					
30	24.00-25.00	Core	---	0.34	34.00	Nil	25.00				

DS = Disturbed Sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, Core = Rock Sample, ® = Refusal.

Annexure II
Borehole Log

Borehole No. BH - 24
Location Galathea, Great Nicobar
Co-ordinate E 593280.00, N 754740.00
R.L. (m) 5.954

Borehole Depth 20.00 m
Water Table 0.00 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	7,13,15 (28)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	10,17,22 (39)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	8,11,13 (24)	---	---	---				
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	7,13,14 (27)	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	8,12,17 (29)	---	---	---				
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.45	SPT	8,10,12 (22)	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.95	SPT	11,19,24 (43)	---	---	---	10.50	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.39	SPT	28,37,52 blows/9cm ®	---	---	---				
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.76	SPT	45,59 blows / 11 cm ®	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

Annexure II Borehole Log

Borehole No. BH - 24
 Location Galathea, Great Nicobar
 Co-ordinate E 593280.00, N 754740.00
 R.L. (m) 5.954

Borehole Depth 20.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.00-15.08	SPT	57 blows / 8 cm ®	---	---	---	20.00	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).	Nil	Grey
31	15.50-16.00	DS	---	---	---	---				
32	16.00-16.50	DS	---	---	---	---				
33	16.50-16.95	SPT	10,16,27 (43)	---	---	---				
34	17.00-17.50	DS	---	---	---	---				
35	17.50-18.00	DS	---	---	---	---				
36	18.00-18.45	SPT	9,14,20 (34)	---	---	---				
37	18.50-19.00	DS	---	---	---	---				
38	19.00-20.00	DS	---	---	---	---				
39	19.50-19.95	SPT	9,15,23 (38)	---	---	---				
40	20.00-20.45	SPT	11,18,26 (44)	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 25
 Location Galathea, Great Nicobar
 Co-ordinate E 593140.00, N 754660.00
 R.L. (m) 8.983

Borehole Depth 20.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Brownish grey, wet, medium dense, silty fine sand.	Nil	Grey
2	1.00-1.40	UDS	(Slipped)	---	---	---				
3	1.50-1.95	SPT	3,5,5 (10)	---	---	---				
4	2.00-2.50	DS	---	---	---	---				
5	2.50-3.00	DS	---	---	---	---				
6	3.00-3.45	SPT	5,6,10 (16)	---	---	---				
7	3.50-4.00	DS	---	---	---	---				
8	4.00-4.50	DS	---	---	---	---				
9	4.50-4.95	SPT	10,17,22 (39)	---	---	---	4.50	Brownish grey, wet, dense to very dense, silty fine sand (Decomposed sedimentary rock).		
10	5.00-5.50	DS	---	---	---	---				
11	5.50-6.00	DS	---	---	---	---				
12	6.00-6.45	SPT	16,25,27 (52)	---	---	---				
13	6.50-7.00	DS	---	---	---	---				
14	7.00-7.50	DS	---	---	---	---				
15	7.50-7.95	SPT	18,24,31 (55)	---	---	---				
16	8.00-8.50	DS	---	---	---	---				
17	8.50-9.00	DS	---	---	---	---				
18	9.00-9.25	SPT	39,57 blows / 10 cm ®	---	---	---				
19	9.50-10.00	DS	---	---	---	---				
20	10.00-10.50	DS	---	---	---	---				
21	10.50-10.72	SPT	47,58 blows / 7 cm ®	---	---	---				
22	11.00-11.50	DS	---	---	---	---				
23	11.50-12.00	DS	---	---	---	---				
24	12.00-12.08	SPT	52 blows / 8 cm ®	---	---	---				
25	12.50-13.00	DS	---	---	---	---				
26	13.00-13.50	DS	---	---	---	---				
27	13.50-13.55	SPT	57 blows / 5 cm ®	---	---	---				
28	14.00-14.50	DS	---	---	---	---				
29	14.50-15.00	DS	---	---	---	---				

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.

**Annexure II
Borehole Log**

Borehole No. BH - 25
 Location Galathea, Great Nicobar
 Co-ordinate E 593140.00, N 754660.00
 R.L. (m) 8.983

Borehole Depth 20.00 m
 Water Table 0.00 m
 Boring/Drilling Rotary core drilling
 Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m) (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m)	Recovery (%)	RQD (%)			Water loss	Colour
30	15.00-15.10	SPT	62 blows / 10 cm ®	---	---	---	15.50	Brownish grey, moderately to partially weathered sedimentary rock (Shale/siltstone).	Nil	Grey
31	15.10-16.50	Core	---	0.33	23.57	Nil				
32	16.50-18.00	Core	---	0.31	20.67	Nil				
33	18.00-19.50	Core	---	0.38	25.33	Nil				
34	19.50-20.00	Core	---	0.13	26.00	Nil	20.00			

DS = Disturbed sample, UDS = Undisturbed soil sample, SPT = Standard Penetration Test, ® = Refusal.



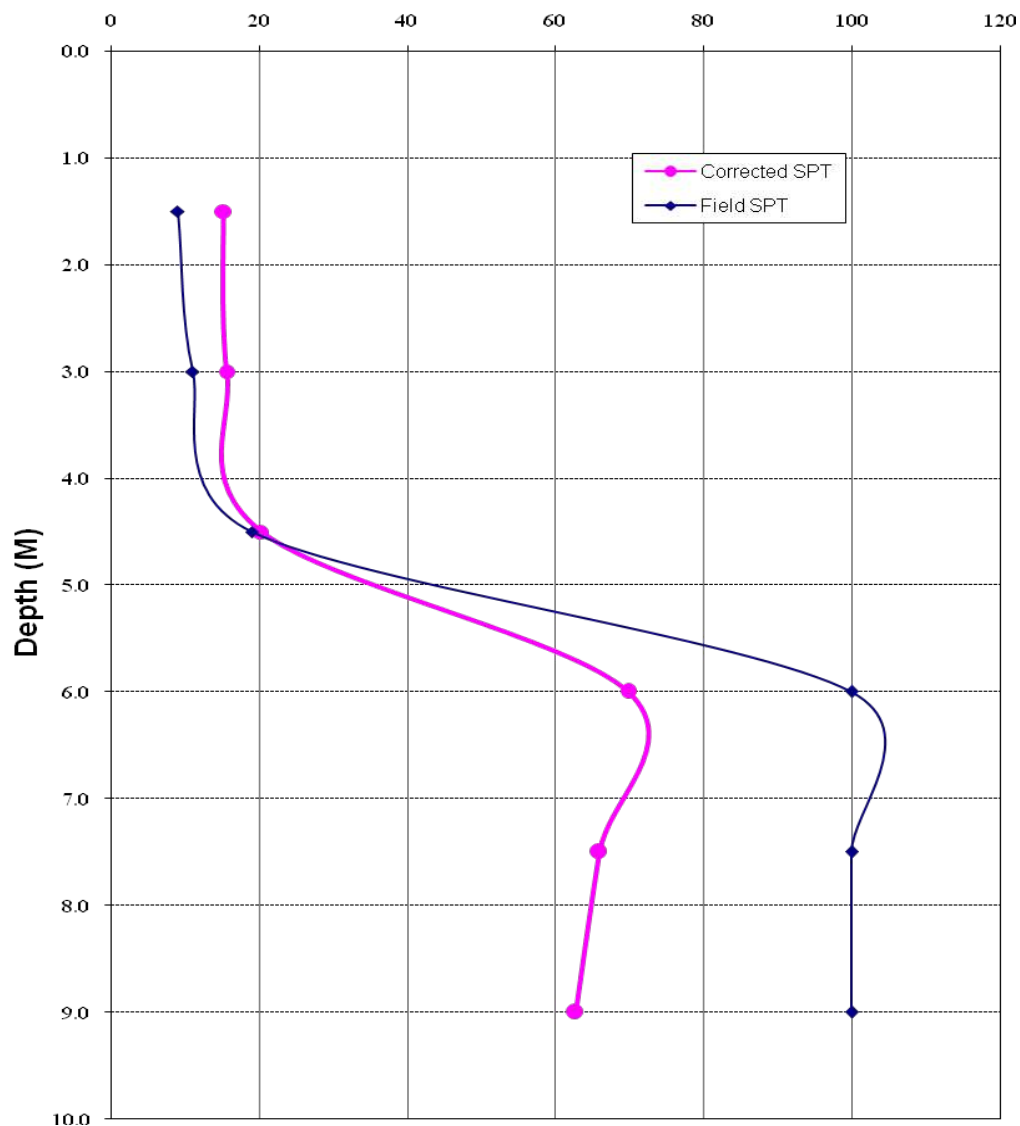
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

Annexure – III Corrected & Uncorrected SPT Curves

i) BH – 1

Field & Corrected 'N' Values



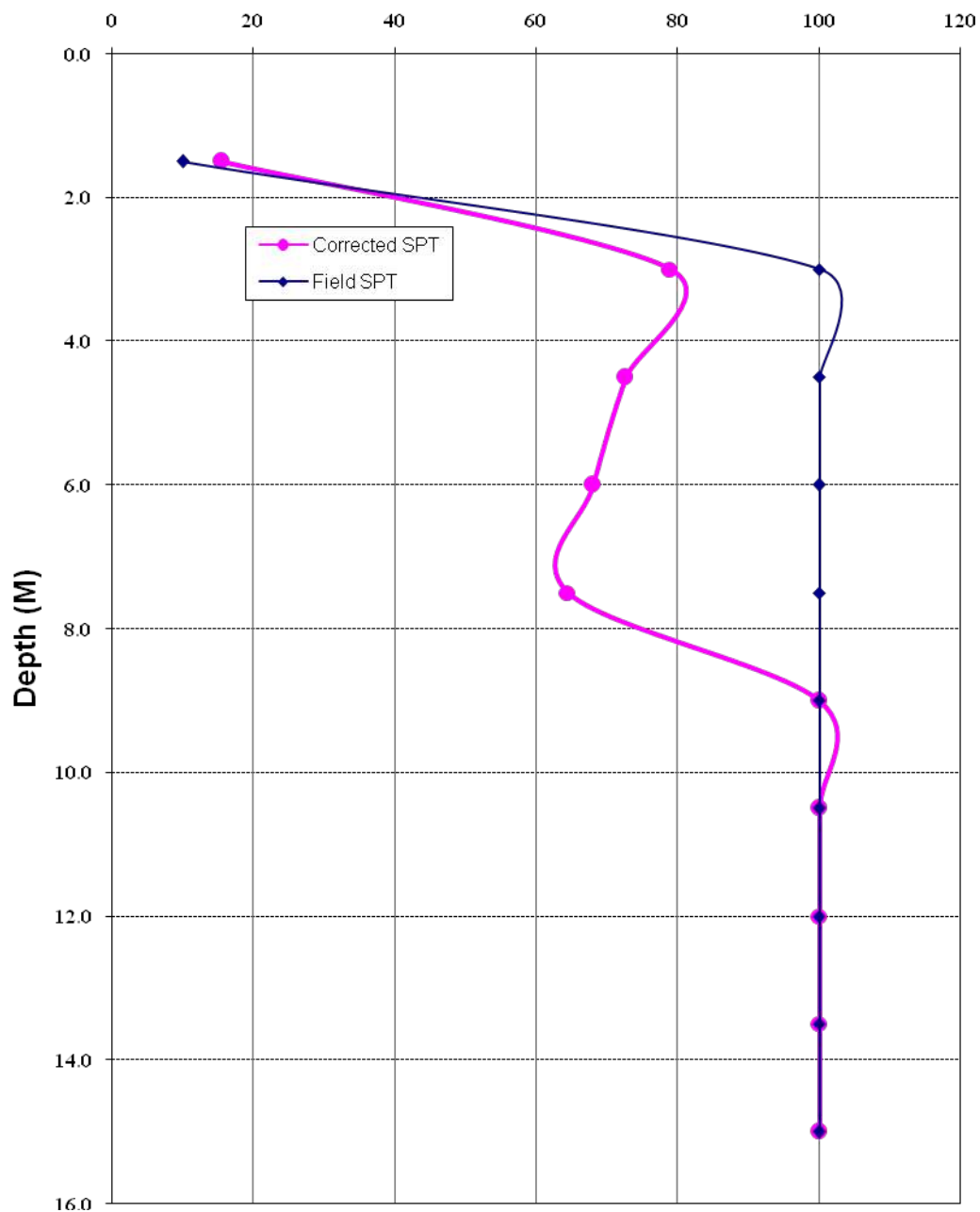


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PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

ii) BH – 3

Field & Corrected 'N' Values



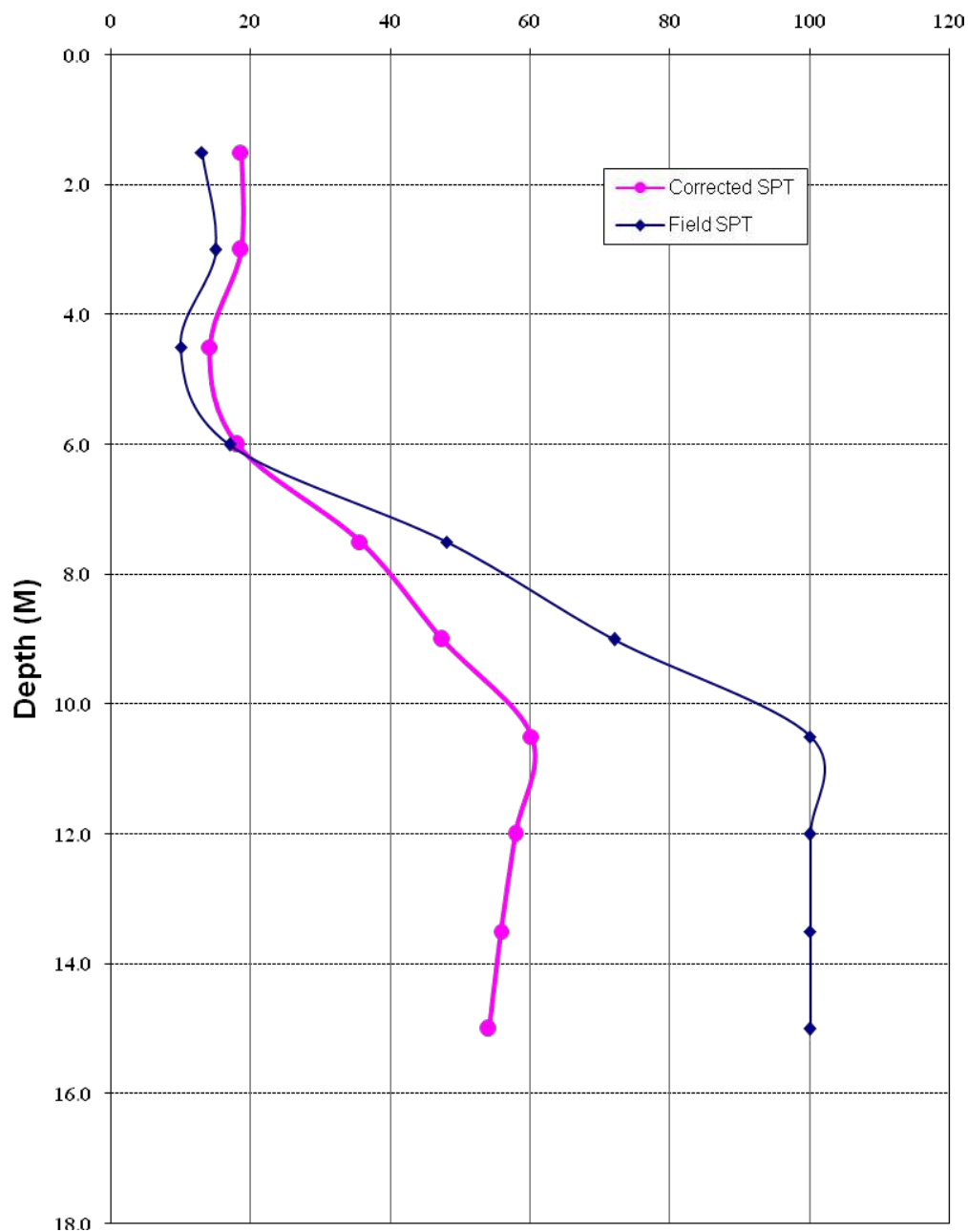


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PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

iii) BH – 4

Field & Corrected 'N' Values



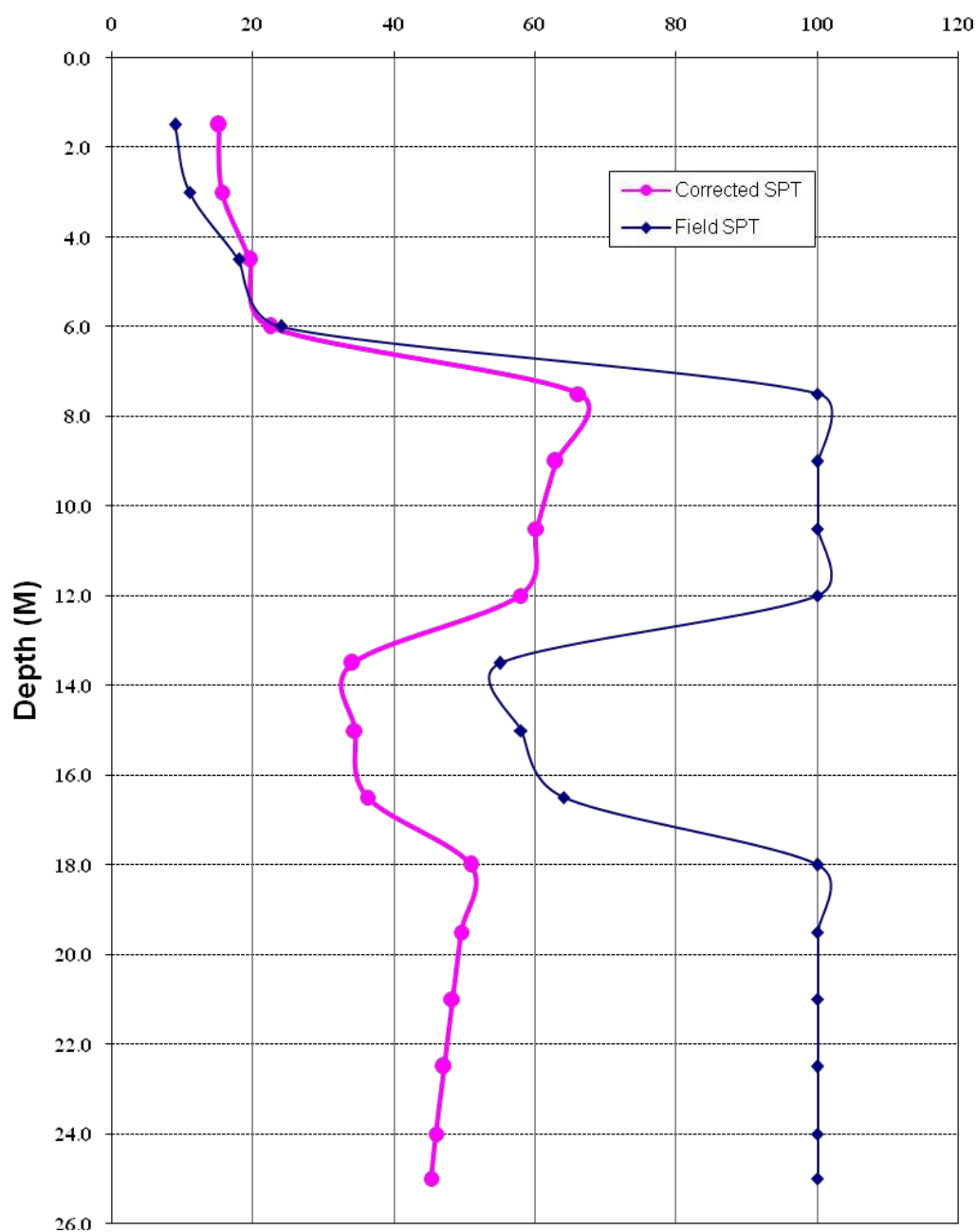


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

iv) BH – 5

Field & Corrected 'N' Values



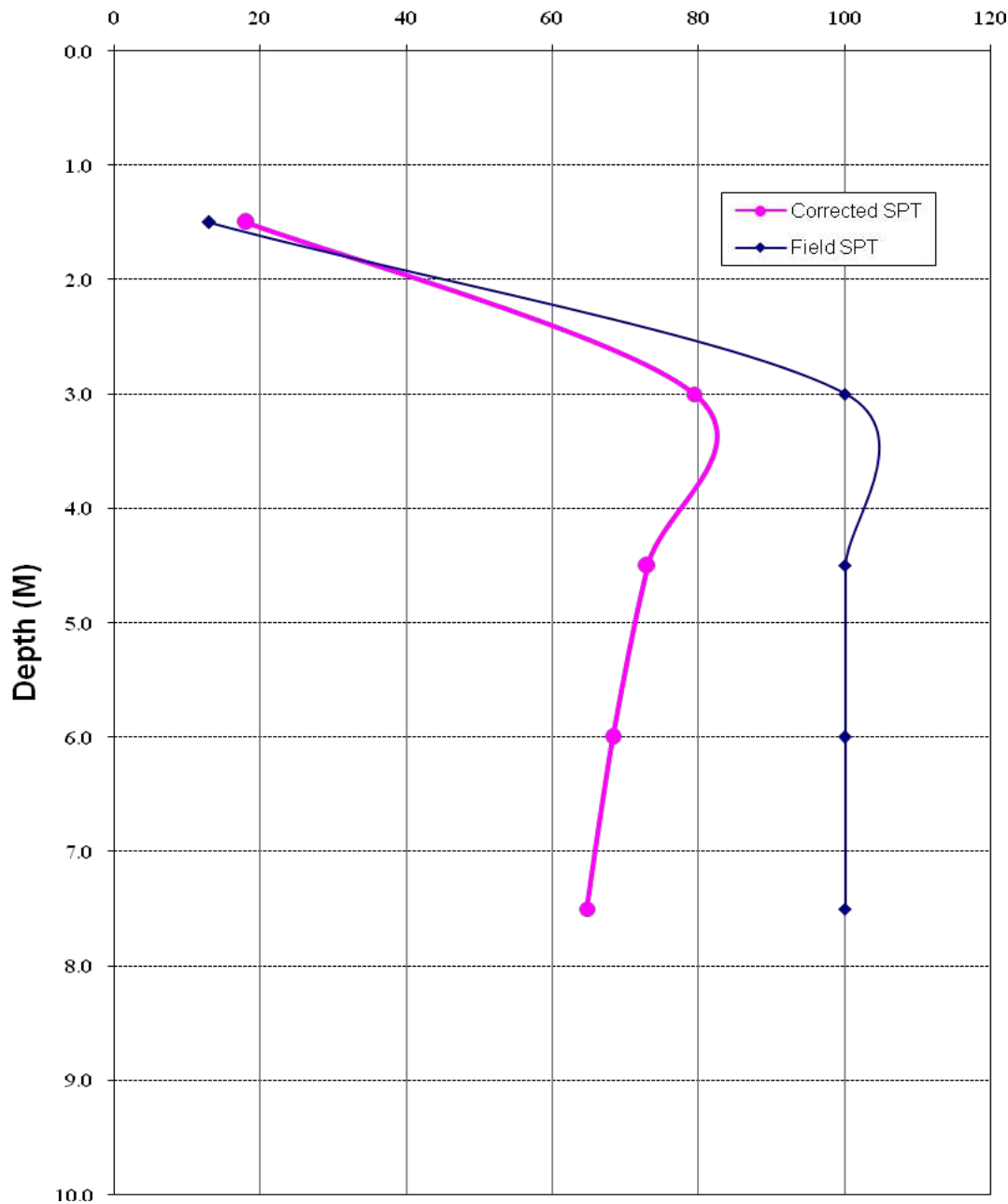


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

v) BH – 6

Field & Corrected 'N' Values



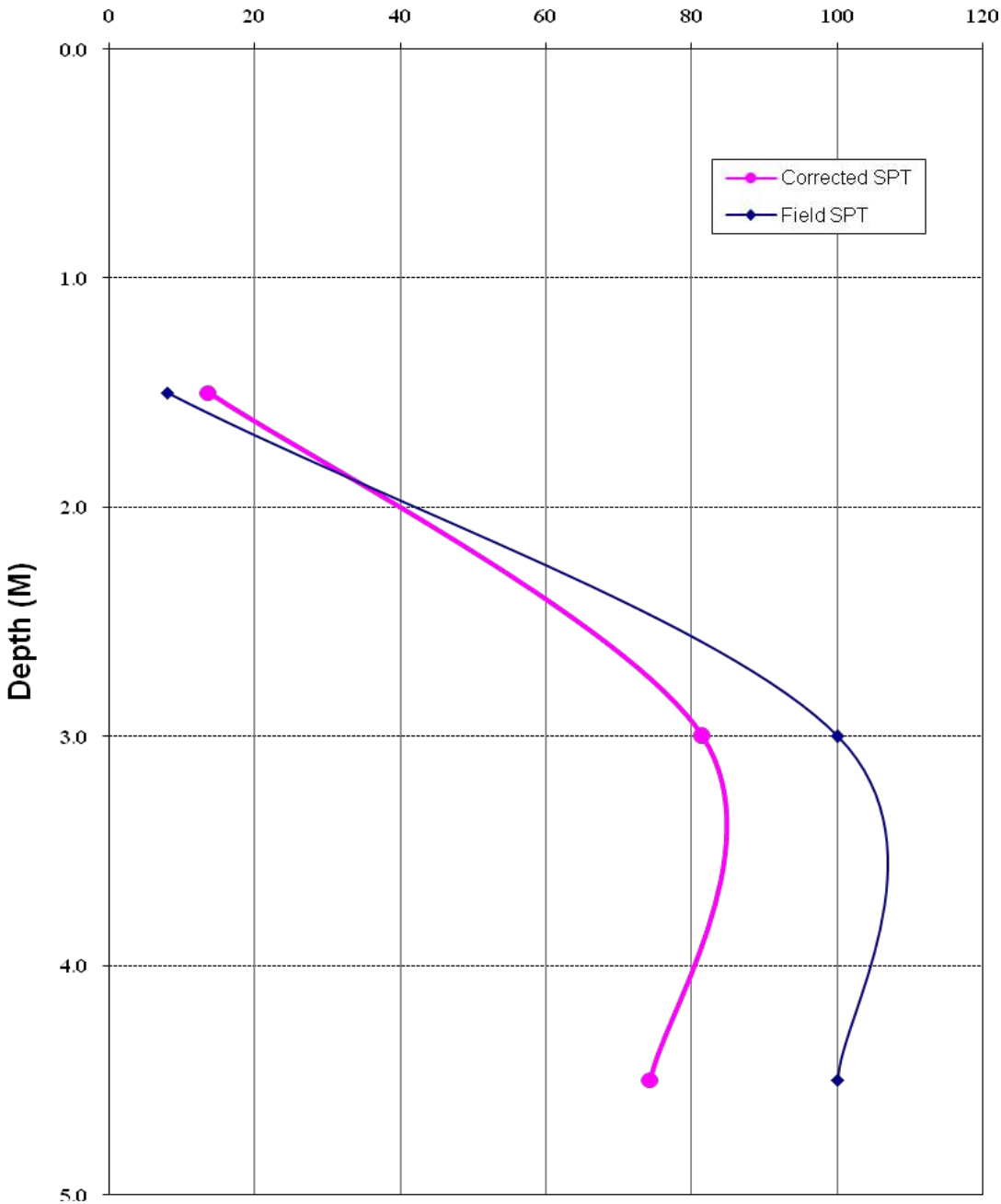


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

vi) BH – 7

Field & Corrected 'N' Values



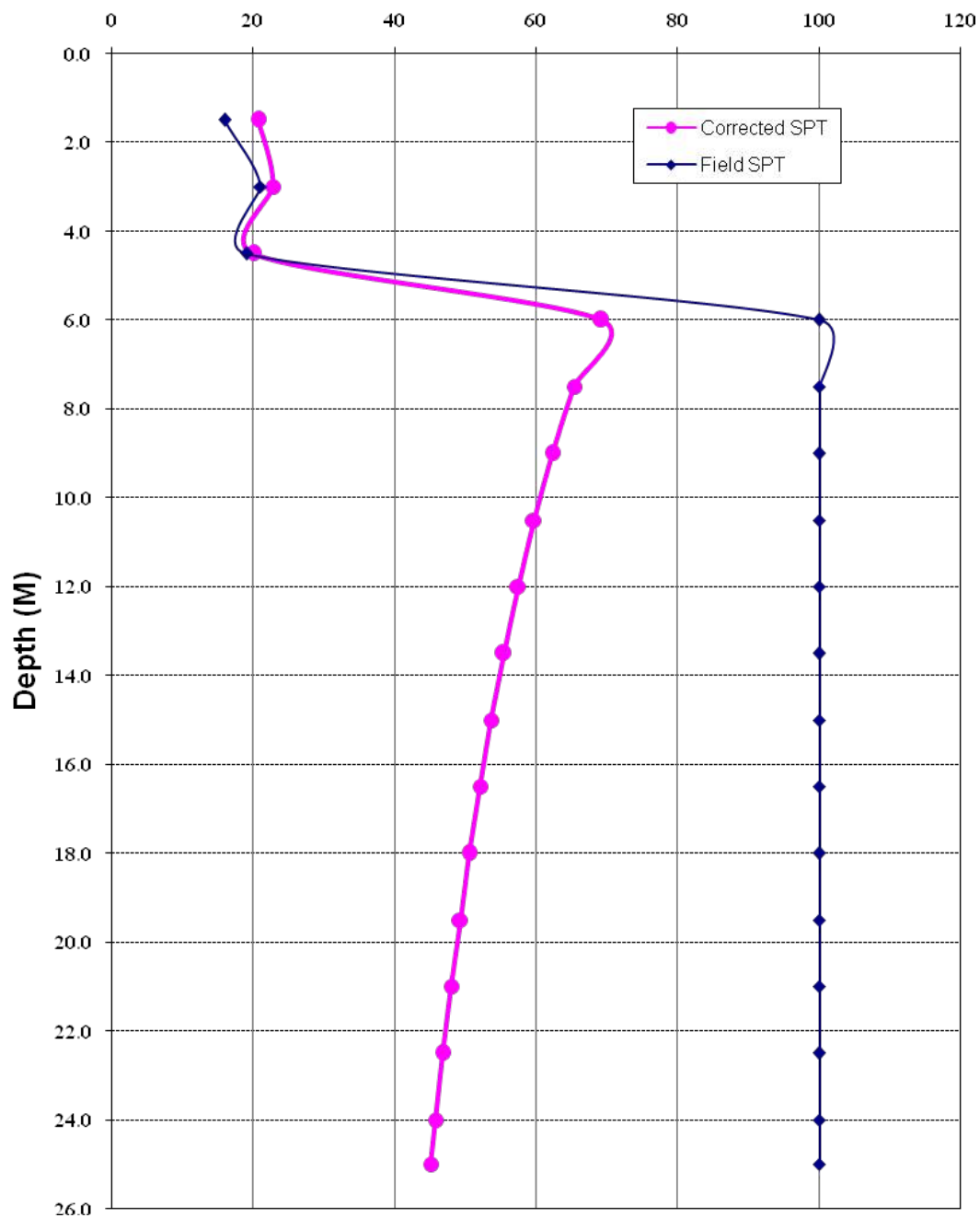


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

vii) BH – 8

Field & Corrected 'N' Values



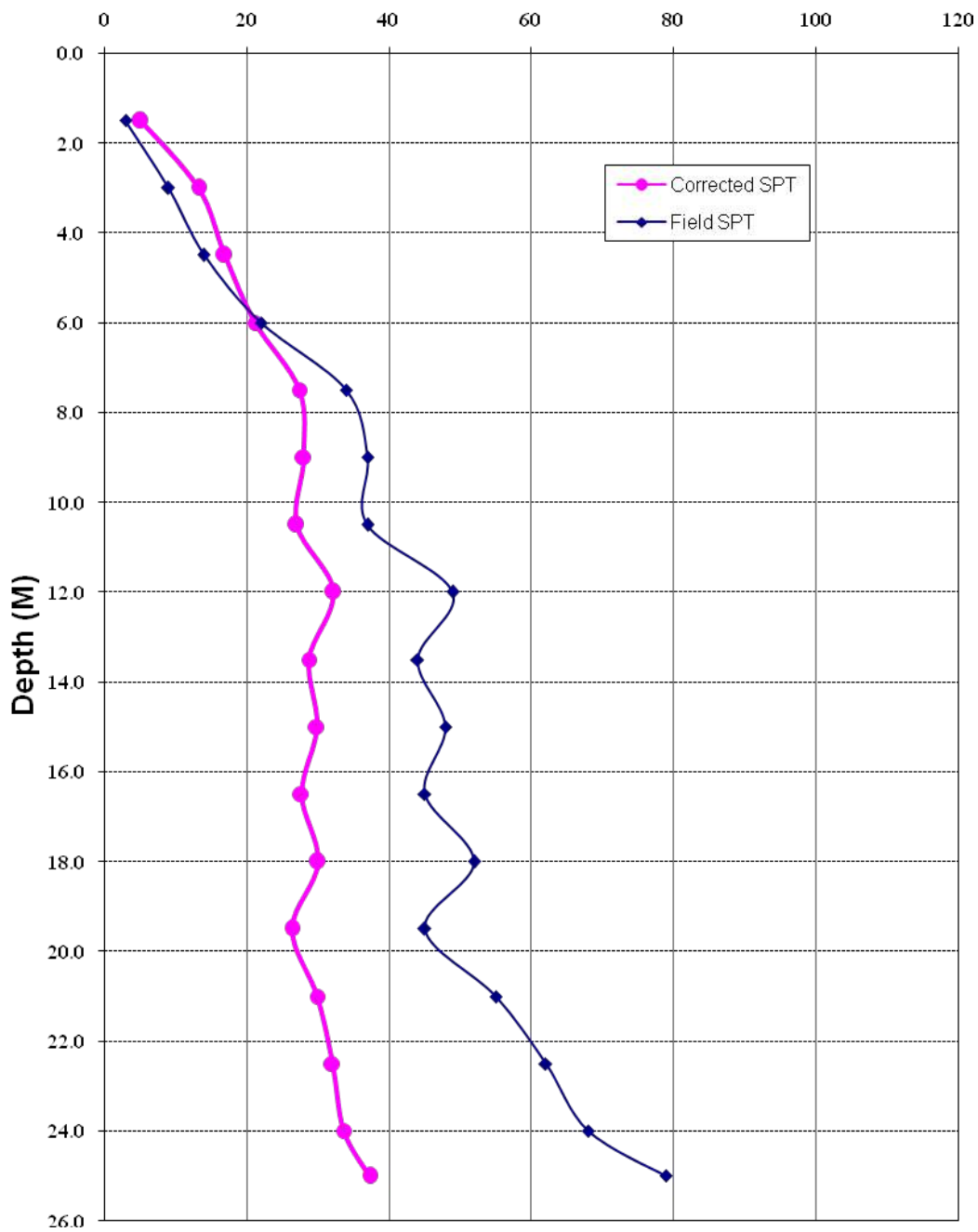


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

viii) BH – 9

Field & Corrected 'N' Values



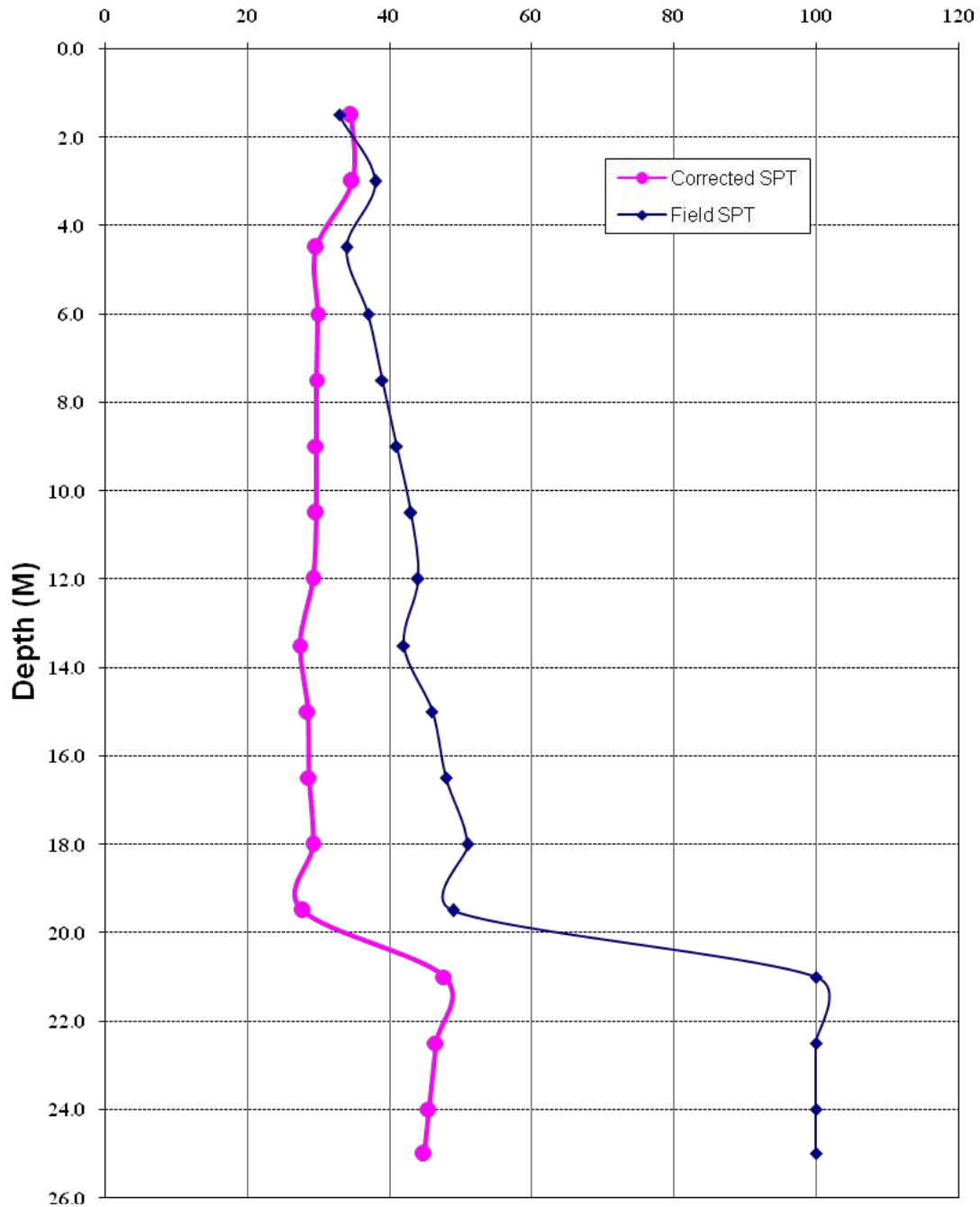


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

ix) BH – 10

Field & Corrected 'N' Values



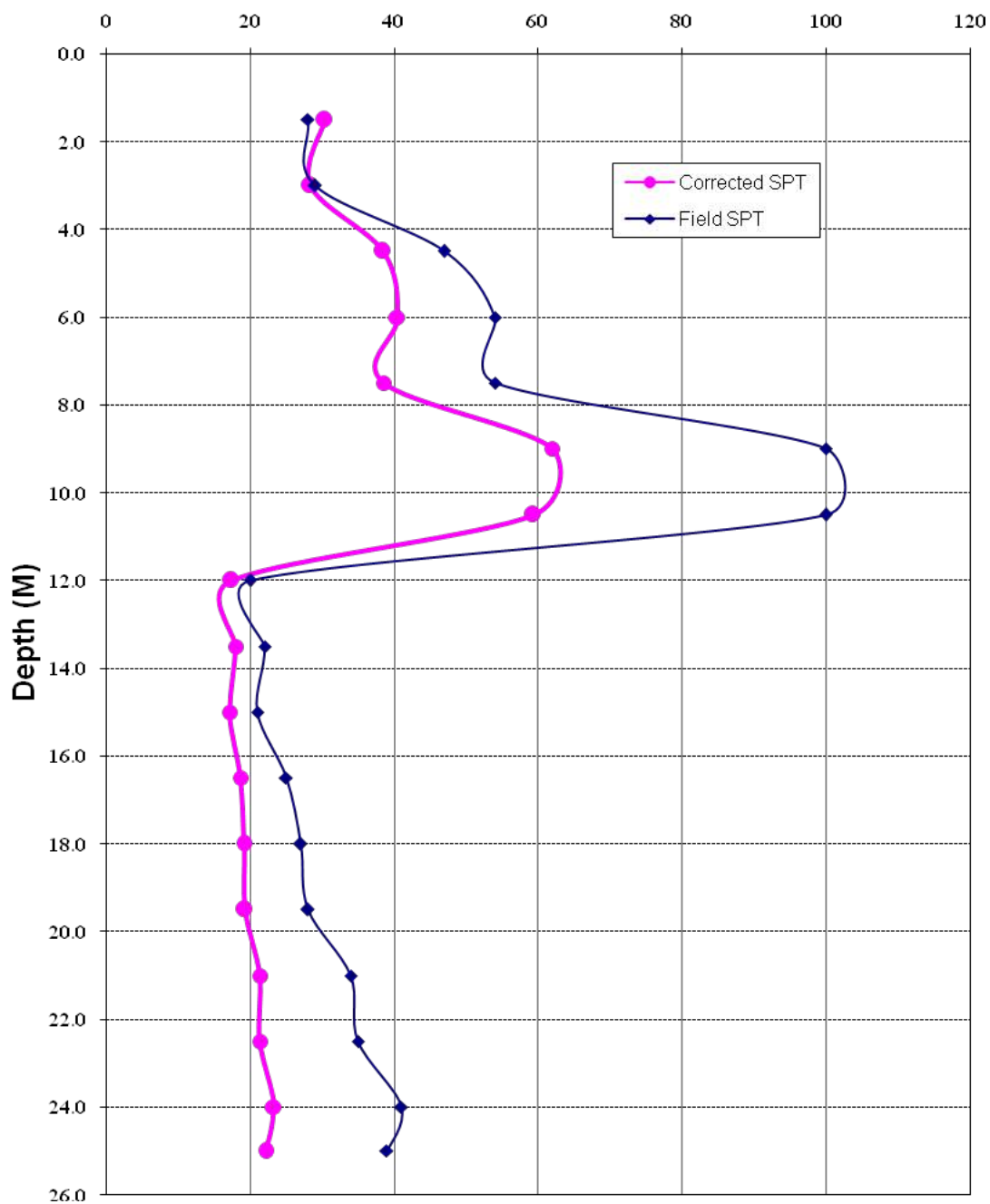


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

x) BH – 11

Field & Corrected 'N' Values



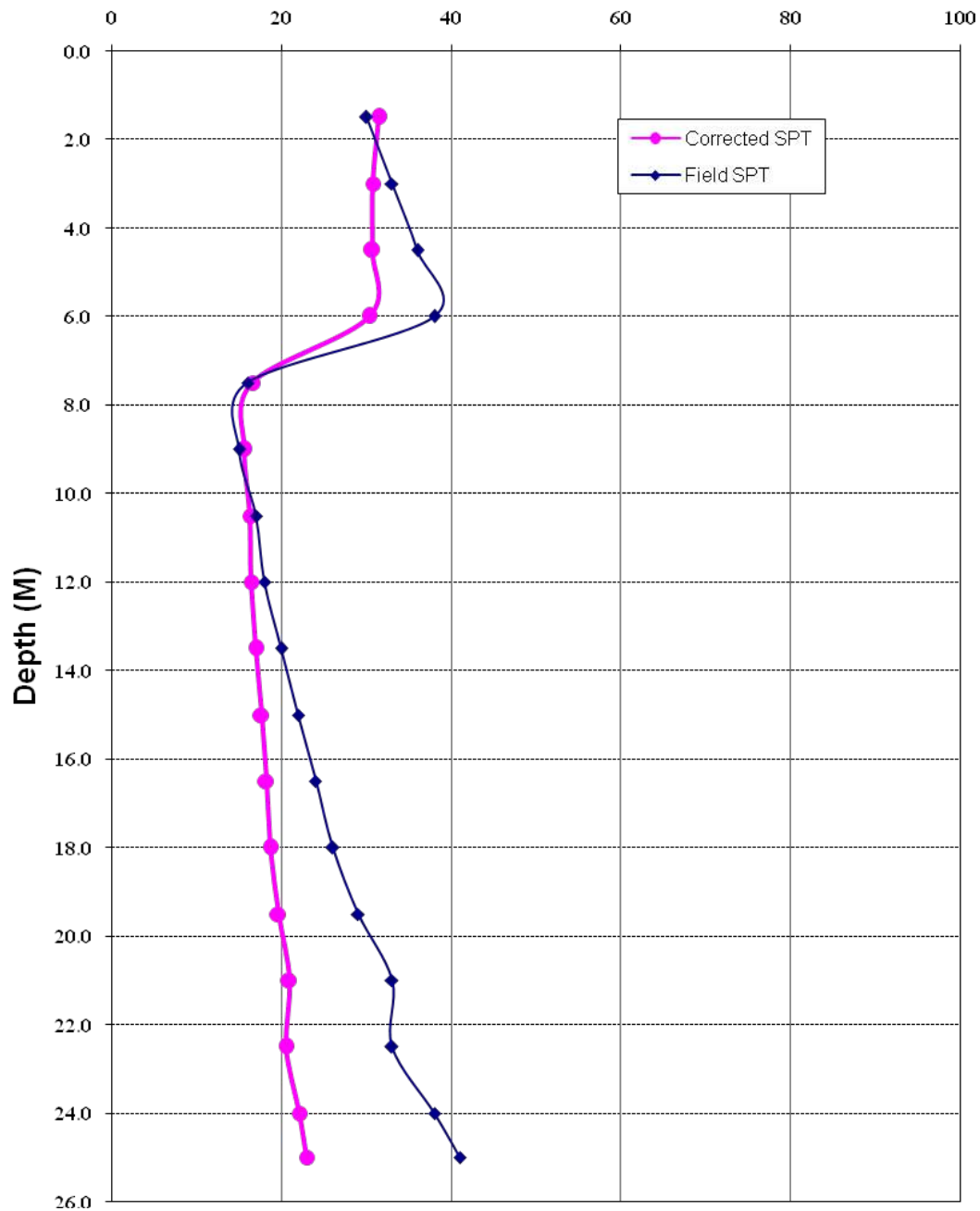


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xi) BH – 12

Field & Corrected 'N' Values



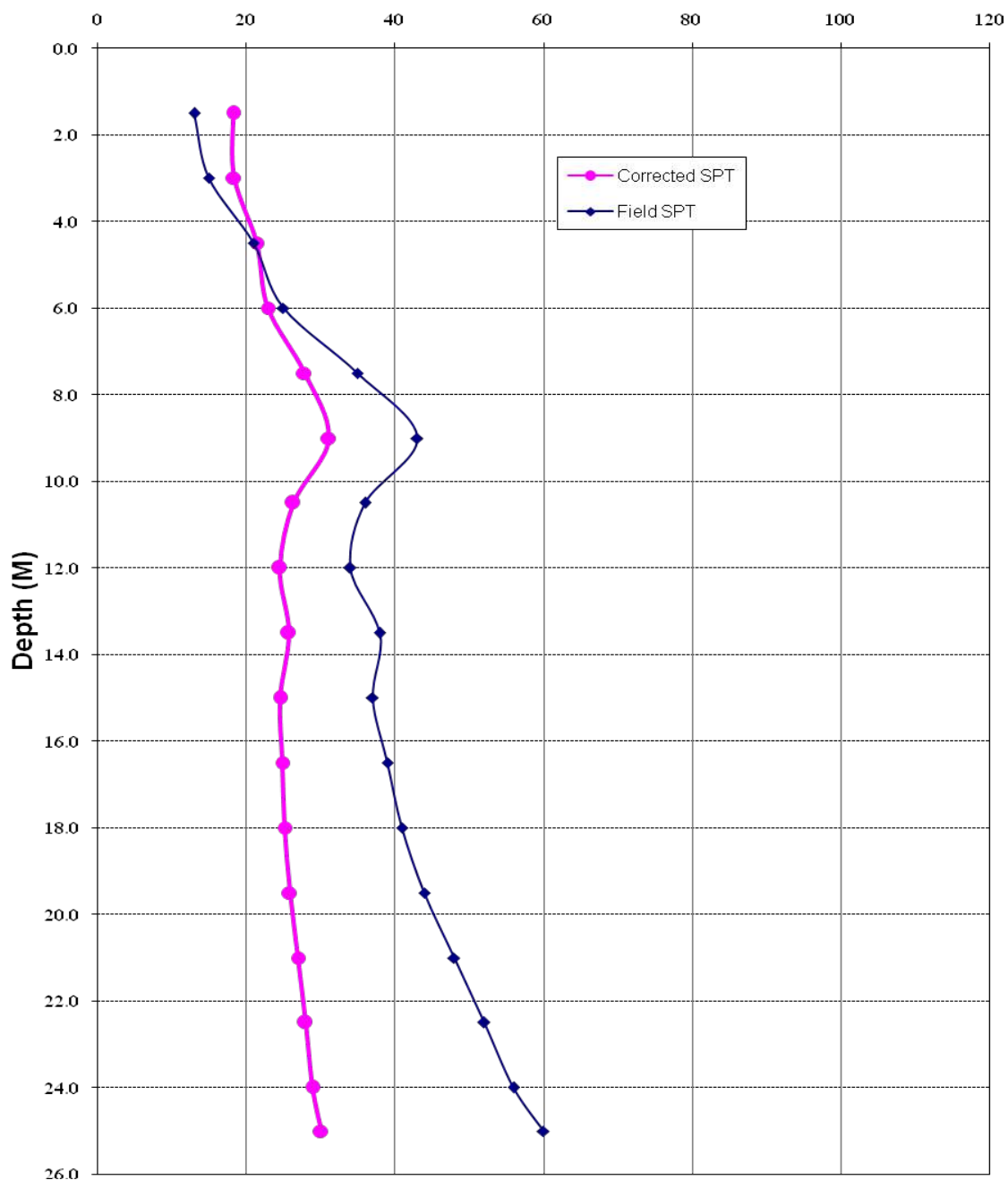


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xii)BH – 13

Field & Corrected 'N' Values



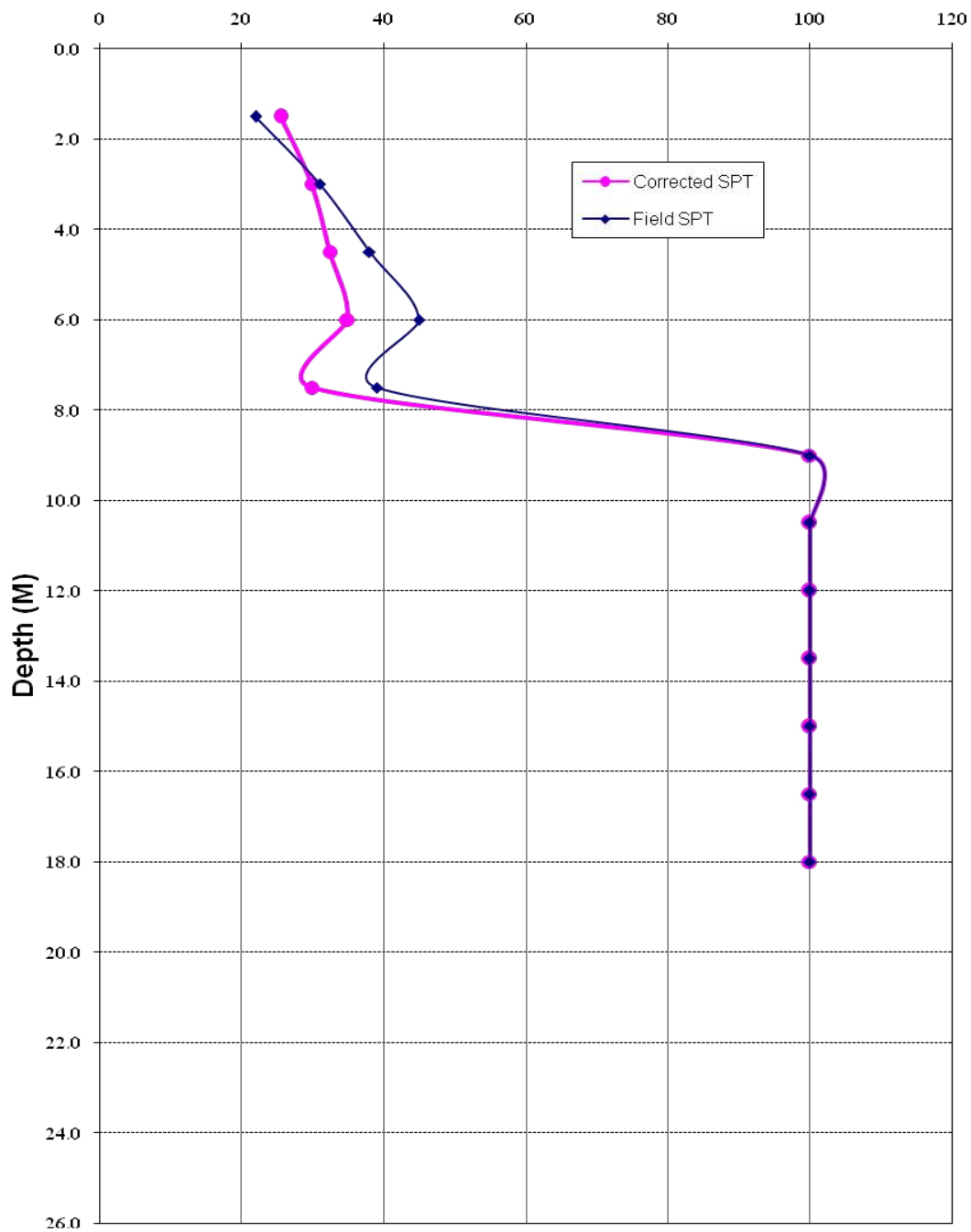


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xiii) BH – 14

Field & Corrected 'N' Values



Rev. 01

Geotechnical Investigation Report

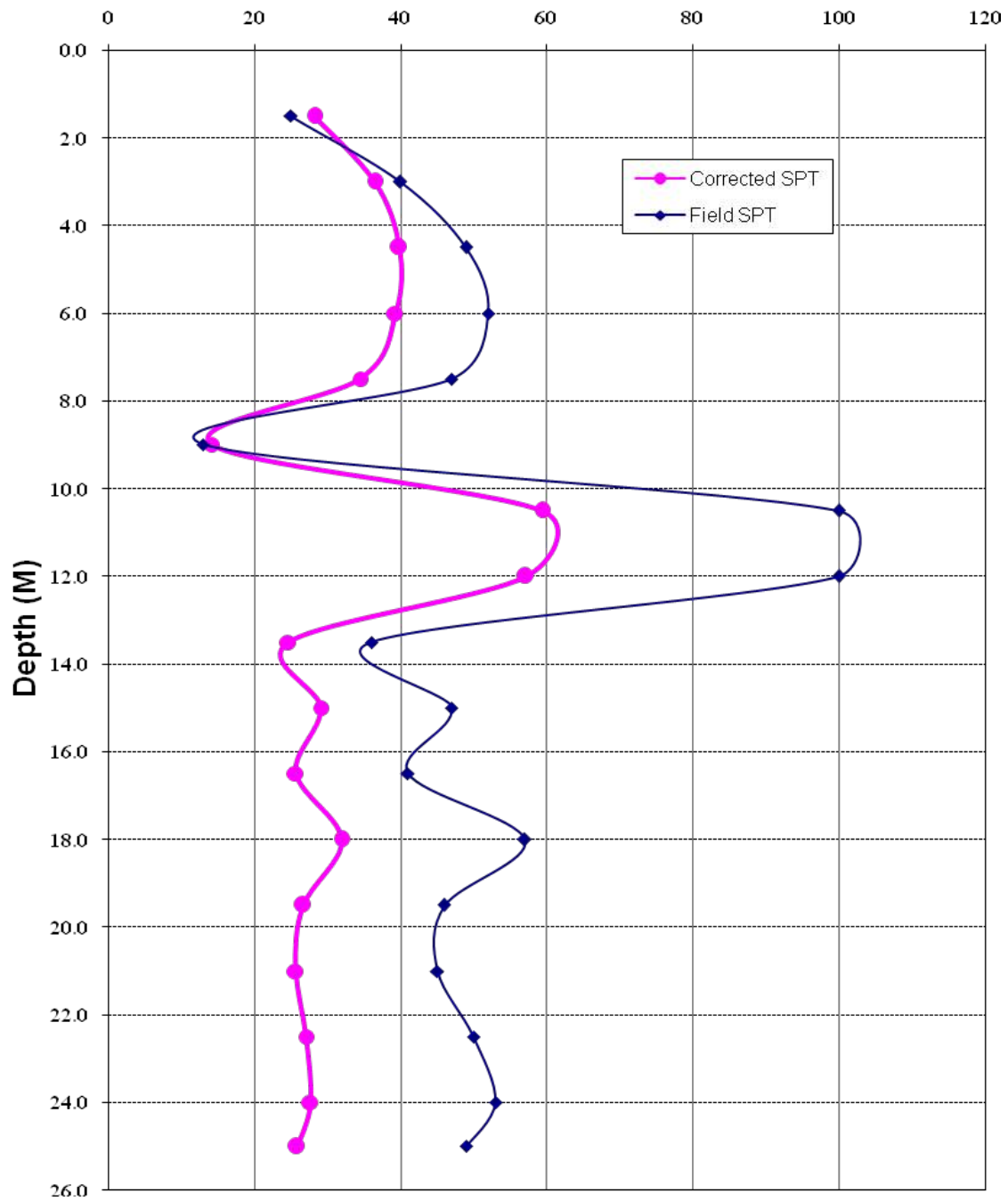


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xiv) BH – 15

Field & Corrected 'N' Values



Rev. 01

Geotechnical Investigation Report

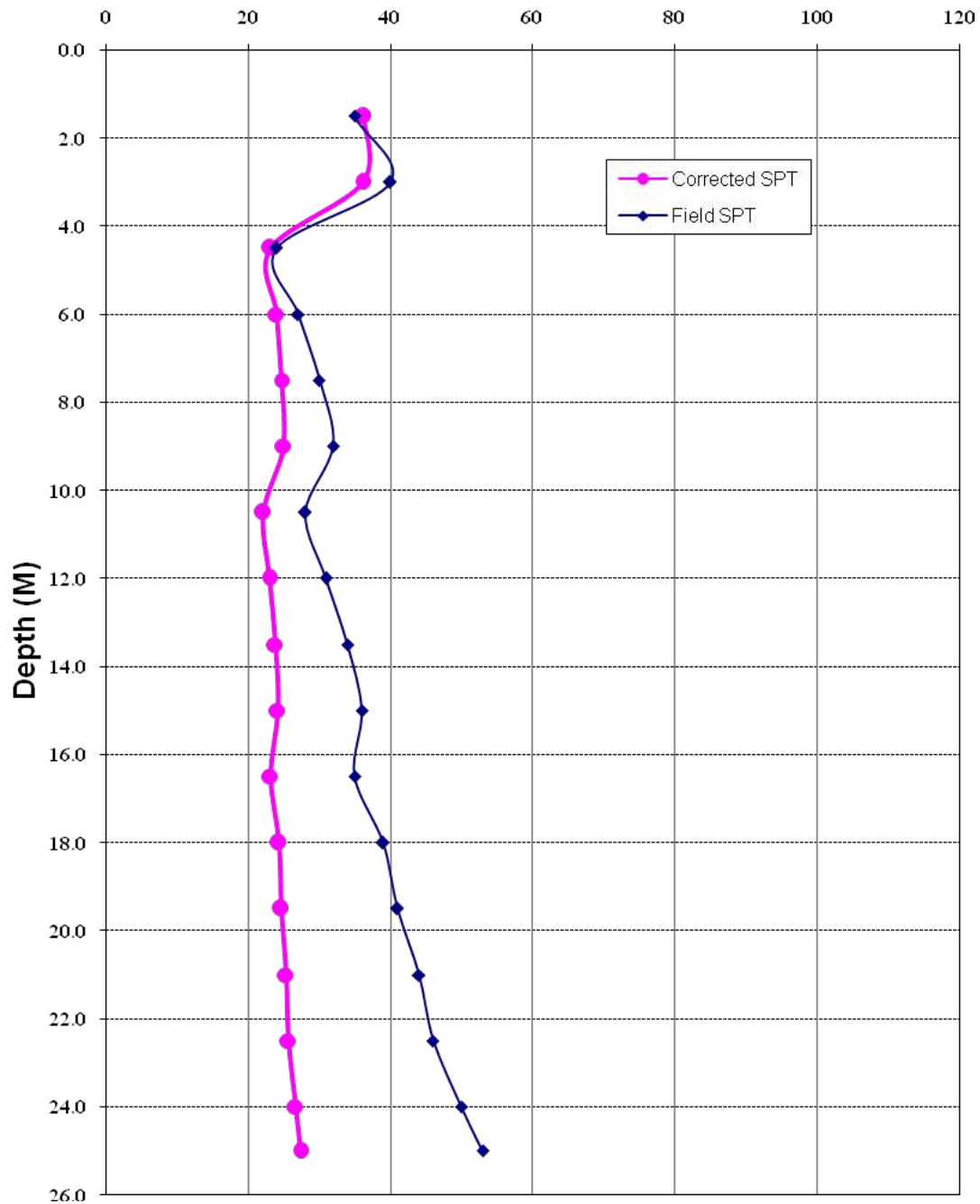


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xv) BH – 16

Field & Corrected 'N' Values



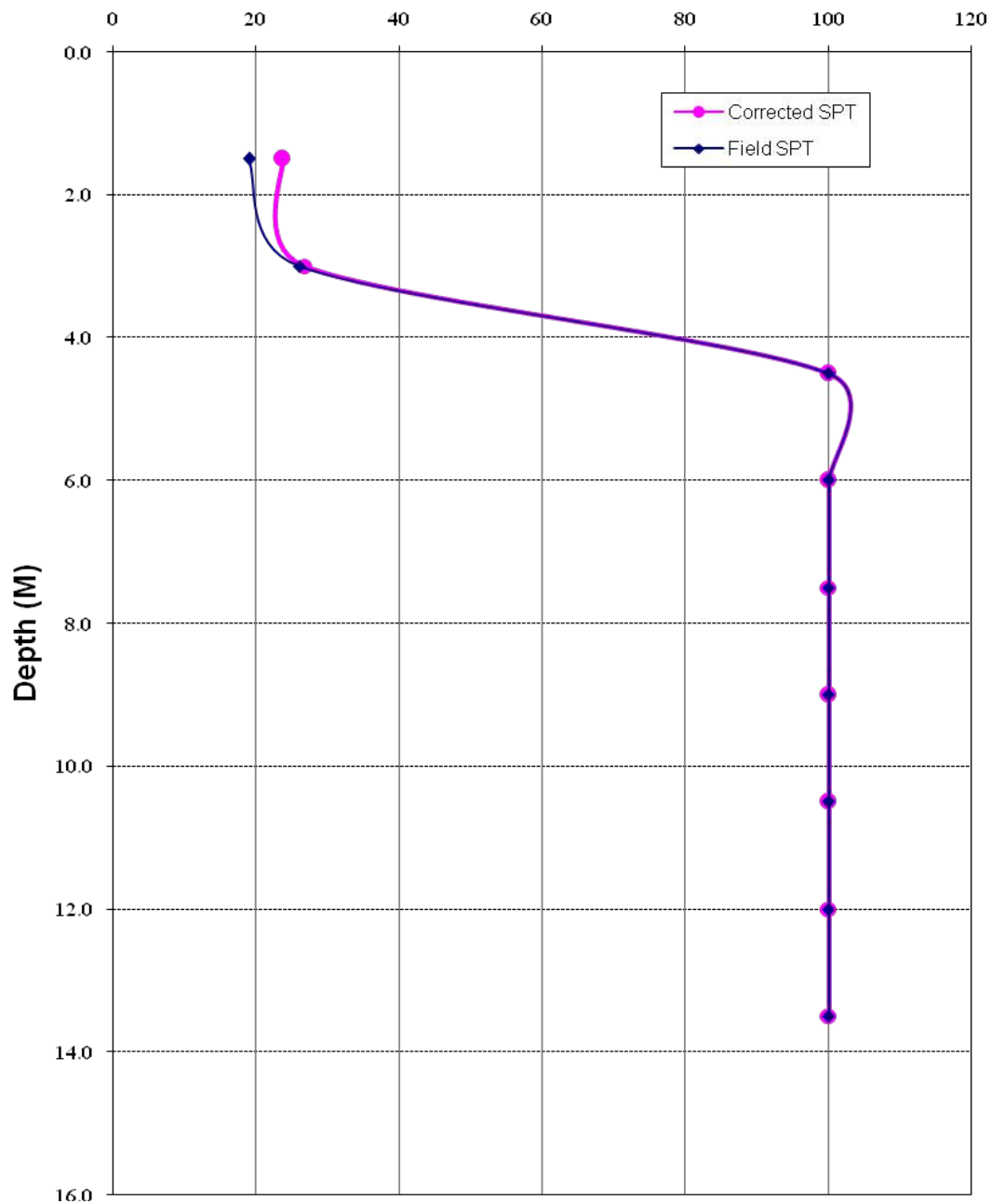


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xvi) BH – 17

Field & Corrected 'N' Values



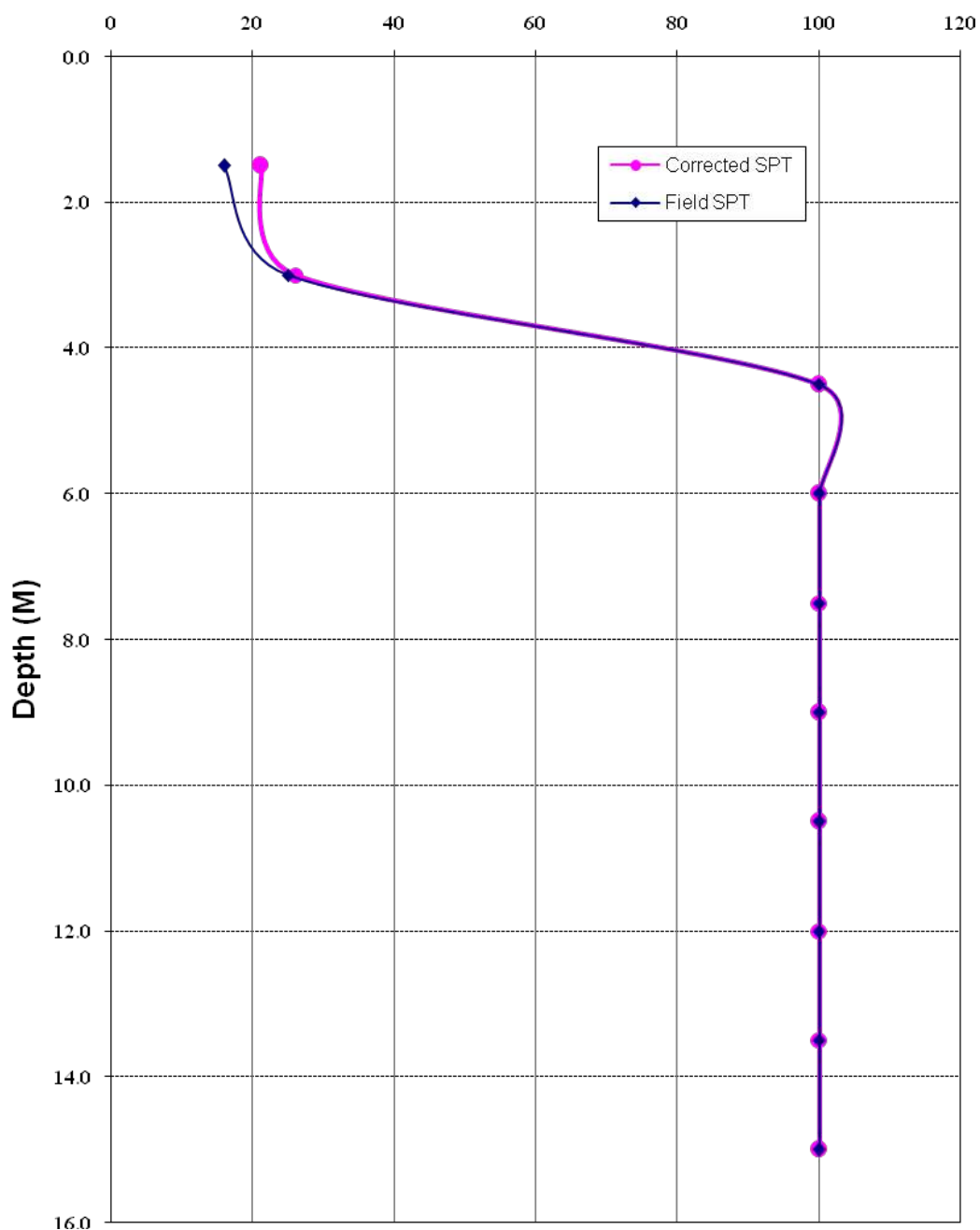


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xvii) BH – 18

Field & Corrected 'N' Values



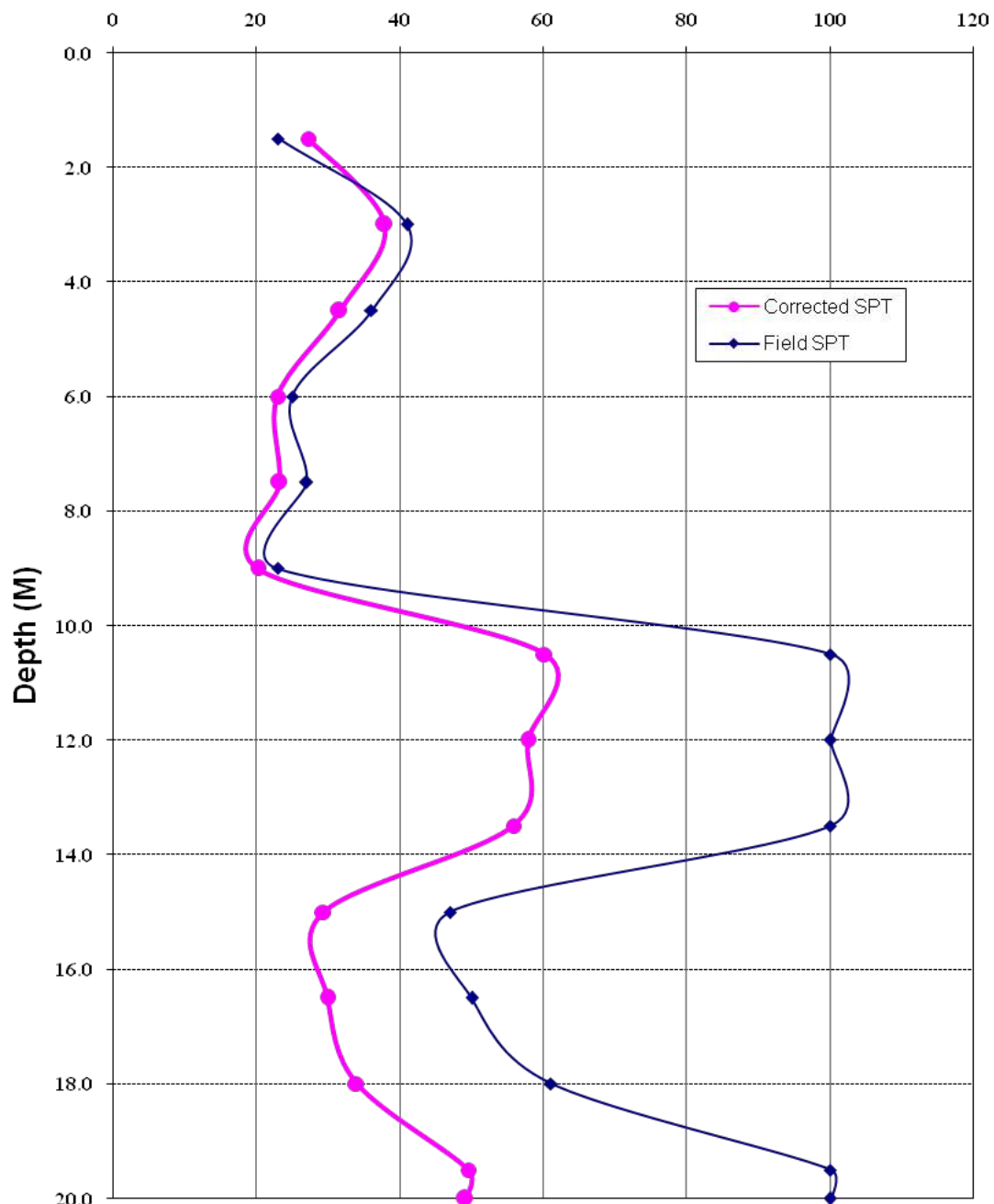


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xviii) BH – 21

Field & Corrected 'N' Values



Rev. 01

Geotechnical Investigation Report

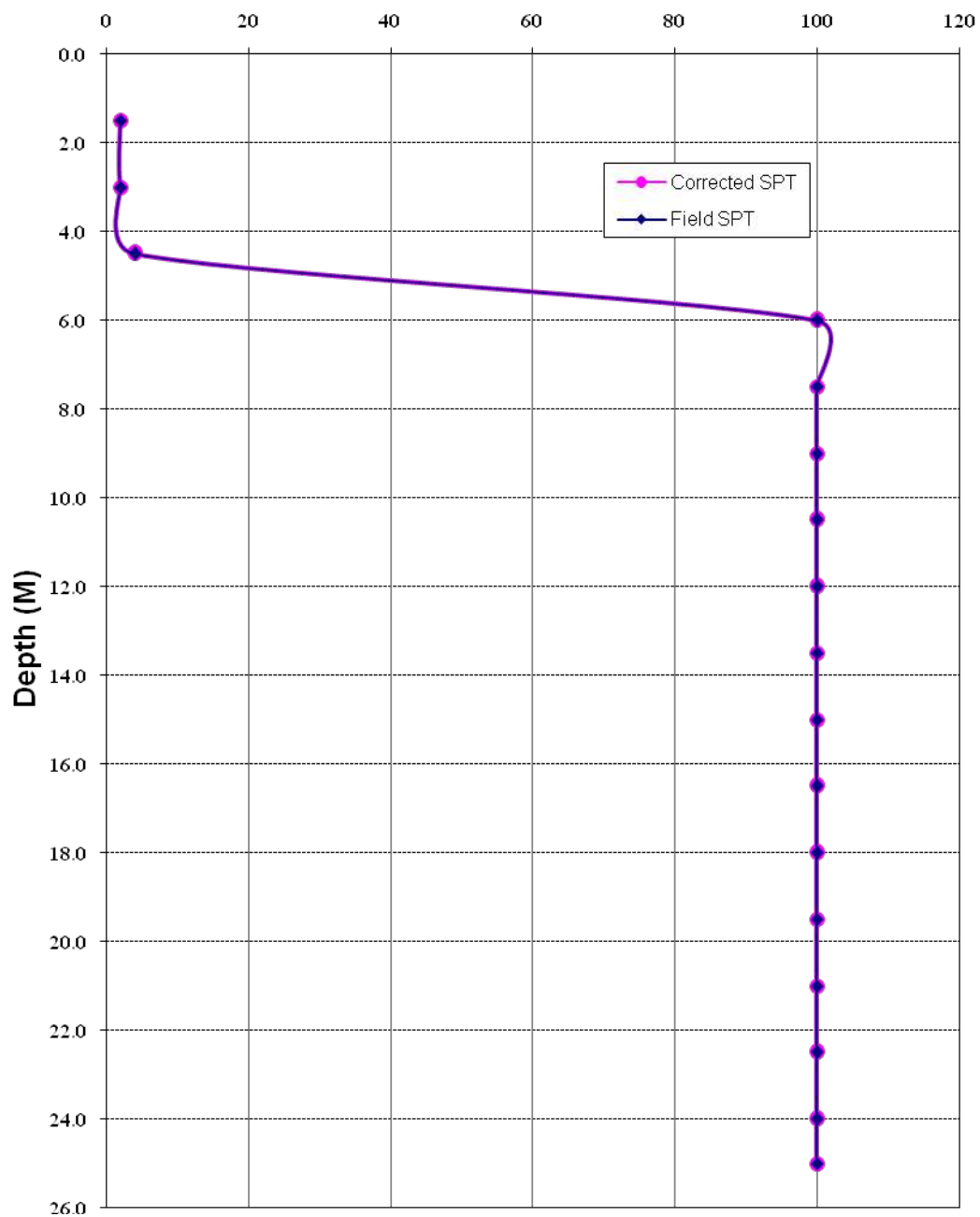


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xix) BH – 22

Field & Corrected 'N' Values



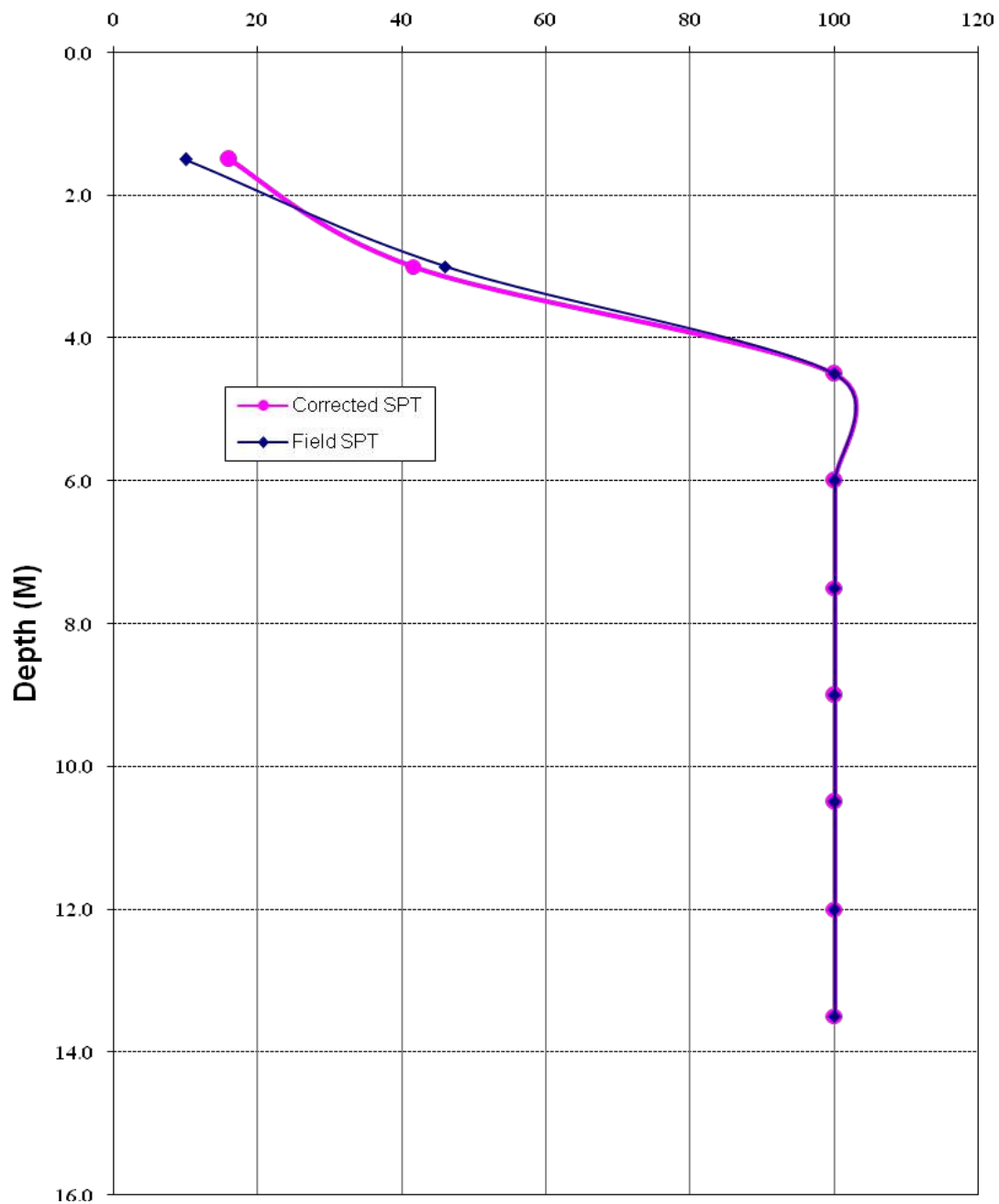


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xx) BH – 23

Field & Corrected 'N' Values



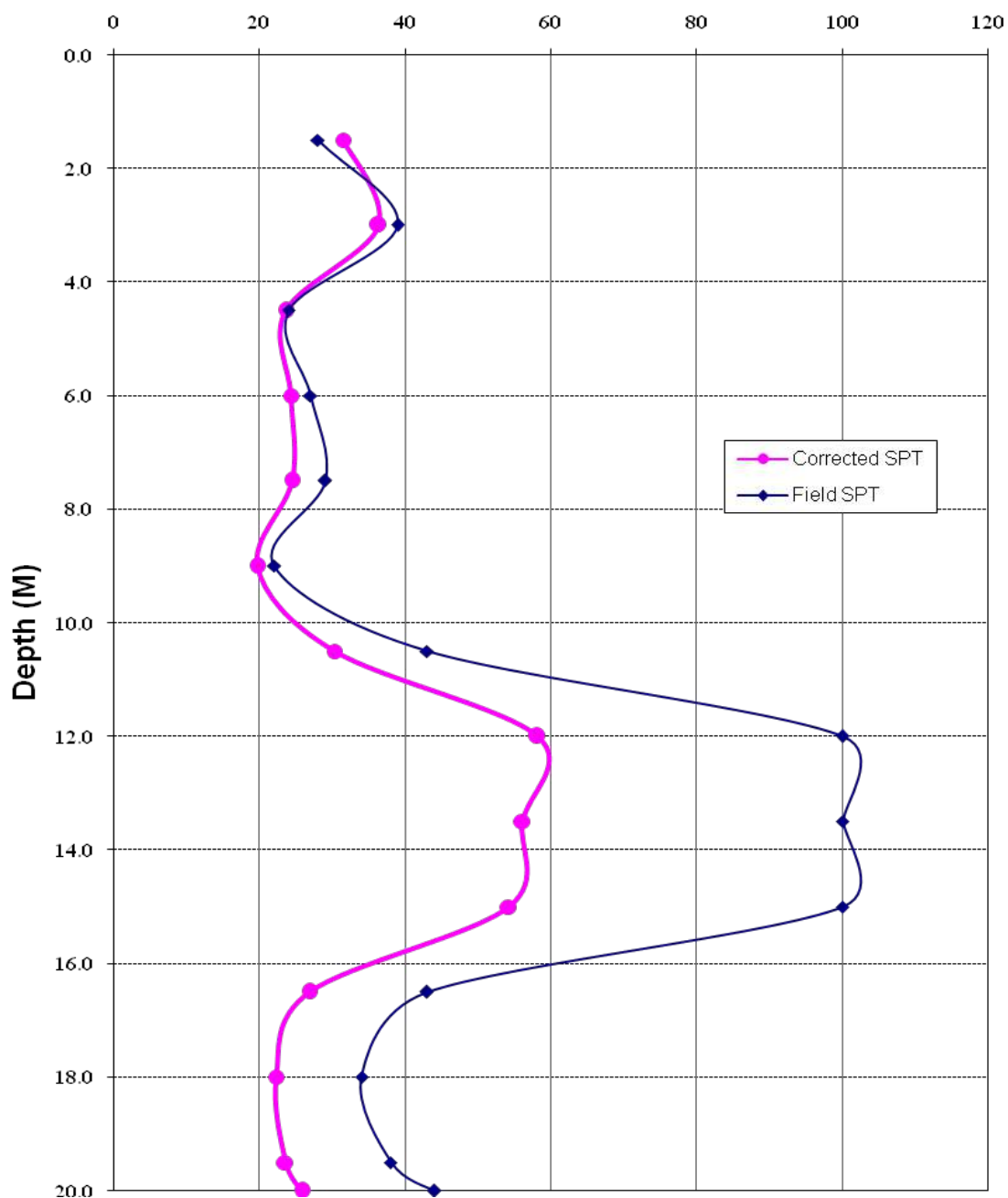


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xxi) BH – 24

Field & Corrected 'N' Values



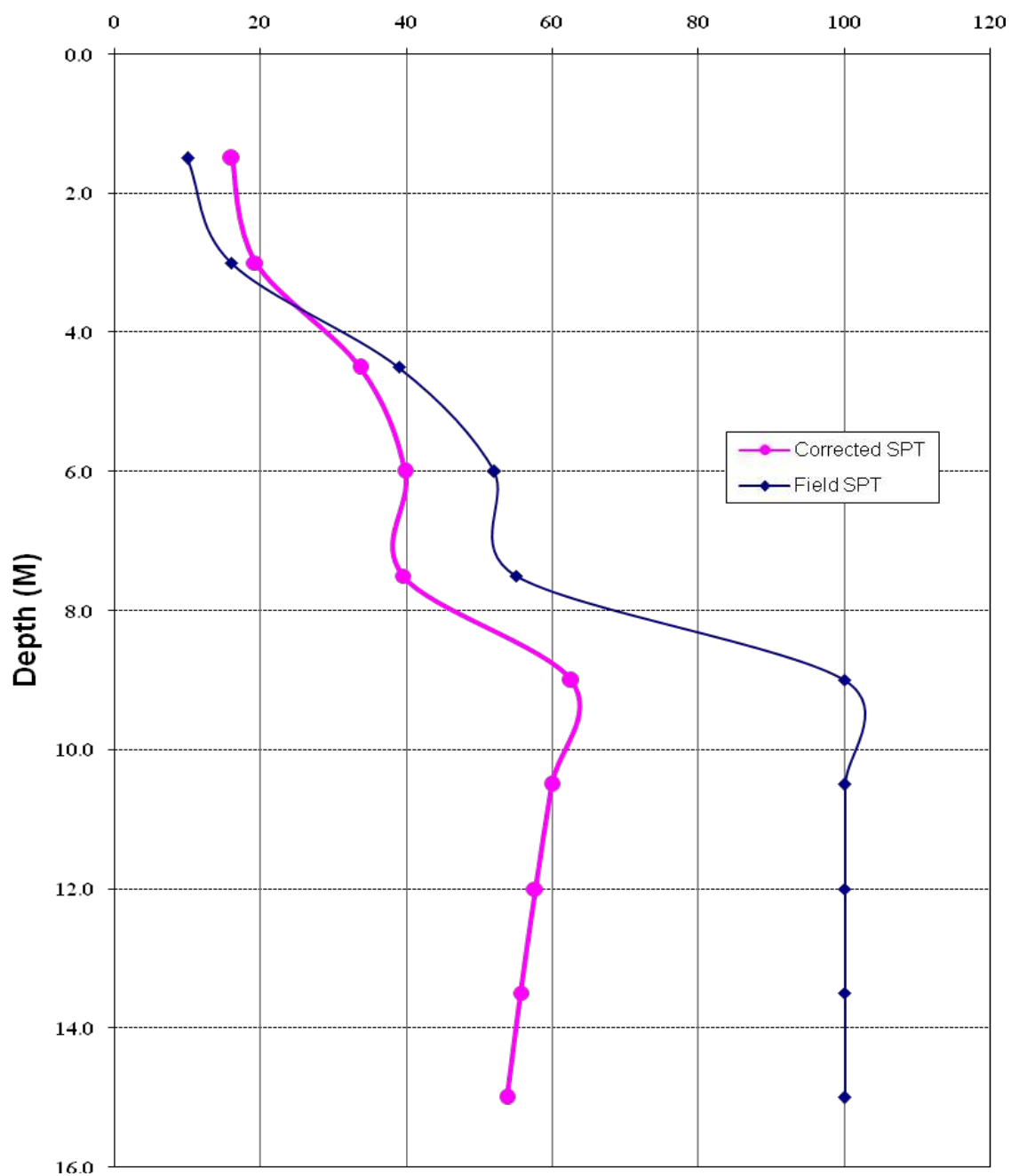


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xxii) BH – 25

Field & Corrected 'N' Values



Annexure - IV
Laboratory Test Result on Soil Sample

BoreHole No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test		
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)
1	3.00	SPT	Silty fine sand	100	100	100	99.58	97.68	57.26	21	0	79	21	0	---	---	NP	---	SM	2.64	---	---	---	1.78	---	DS	0.12	30
1	7.50	SPT	Silty fine sand	99	98.24	97.68	96.89	96.24	53.68	9	1	90	9	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
3	1.50	SPT	Silty fine sand	100	100	99.64	98.15	95.45	50.65	20	0	80	20	0	---	---	NP	---	SM	2.65	---	---	---	1.81	---	DS	0.10	31
3	6.00	SPT	Silty fine sand	99	98.45	97.76	96.55	95.76	55.68	11	1	88	11	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
3	13.50	SPT	Silty fine sand	98	97.56	96.86	95.86	94.56	43.89	12	2	86	12	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
4	1.00	UDS	Silty fine sand	100	100	99.45	98.64	97.12	54.56	23	0	77	23	0	---	---	NP	---	SM	2.65	---	---	---	1.82	---	DS	0.08	32
4	6.00	SPT	Silty fine sand	100	99.46	98.76	97.21	95.86	50.47	16	0	84	16	0	---	---	NP	---	SM	2.67	---	---	---	---	---	---	---	---
4	9.00	SPT	Silty fine sand	100	99.54	97.89	96.68	94.22	48.86	14	0	86	14	0	---	---	NP	---	SM	---	---	---	---	1.87	---	DS	0.05	34
5	4.50	SPT	Silty fine sand	100	100	99.46	98.56	97.86	57.56	25	0	75	25	0	---	---	NP	---	SM	2.63	---	---	---	1.80	---	DS	0.09	32
5	13.50	SPT	Silty fine sand	100	100	100	99.54	98.56	54.16	16	0	84	16	0	---	---	NP	---	SM	2.65	---	---	---	1.86	---	DS	0.03	34
5	16.50	SPT	Silty fine sand	99	98.46	97.24	96.24	93.16	47.25	13	1	86	13	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---

UDS = Undisturbed Soil Sample, SPT = Standard Penetration Test, DS = Direct Shear Test, NP = Non Plastic.

Annexure - IV
Laboratory Test Result on Soil Sample

BoreHole No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test		
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)
6	1.50	SPT	Silty fine sand	100	100	100	99.46	98.59	57.56	23	0	77	23	0	---	---	NP	---	SM	2.61	---	---	---	1.79	---	DS	0.10	31
6	6.00	SPT	Silty fine sand	99	98.45	97.38	96.25	94.25	54.26	10	1	89	10	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
7	1.50	SPT	Silty fine sand	100	100	99.68	98.64	95.68	54.68	28	0	72	28	0	---	---	NP	---	SM	2.58	---	---	---	1.77	---	DS	0.13	29
7	3.00	SPT	Silty fine sand	98	97.26	96.35	95.86	94.57	49.86	10	2	88	10	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
8	3.00	SPT	Silty fine sand	100	100	99.68	98.86	93.86	58.59	21	0	79	21	0	---	---	NP	---	SM	2.65	---	---	---	1.82	---	DS	0.07	33
8	10.50	SPT	Silty fine sand	98	97.14	95.45	94.35	90.86	54.59	13	2	85	13	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
9	3.00	SPT	Silty fine sand	100	100	100	100	98.85	52.08	22.11	0	78	22	0	---	---	NP	---	SM	2.66	---	---	---	---	---	---	---	---
9	4.50	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.81	---	DS	0.08	32
9	6.00	SPT	Silty fine sand	100	99.79	99.59	99.31	98.98	52.00	19.05	0	81	19	0	---	---	NP	---	SM	2.66	---	---	---	---	---	---	---	---
9	9.00	SPT	Silty fine sand	100	100	99.12	97.47	94.79	47.11	11.97	0	88	12	0	---	---	NP	---	SM	2.68	---	---	---	---	---	---	---	---
9	12.00	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.86	---	DS	0.05	34

UDS = Undisturbed Soil Sample, SPT = Standard Penetration Test, DS = Direct Shear Test, NP = Non Plastic.

Annexure - IV
Laboratory Test Result on Soil Sample

BoreHole No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test					
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)			
9	15.00	SPT	Silty fine sand	100	100	98.98	98.03	94.51	48.83	14.83	0	85	15	0	---	---	NP	---	SM	2.62	---	---	---	---	---	---	---	---	---	---	---
9	21.00	SPT	Silty fine sand	100	99.75	98.71	97.13	90.88	47.76	15.09	0	85	15	0	---	---	NP	---	SM	2.65	---	---	---	---	---	---	---	---	---	---	---
10	3.00	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.85	---	DS	0.05	34	---	---	---	
10	4.50	SPT	Silty fine sand	100	99.32	98.46	96.32	92.46	48.16	22.68	0	77	23	0	---	---	NP	---	SM	2.65	---	---	---	---	---	---	---	---	---	---	---
10	6.00	SPT	Silty fine sand	100	98.56	98.04	96.70	94.02	55.37	28.15	0	72	23	5	---	---	NP	---	SM	2.67	---	---	---	---	---	---	---	---	---	---	---
10	10.50	SPT	Silty fine sand	100	100	100	99.80	99.36	78.90	23.88	0	76	24	0	---	---	NP	---	SM	2.64	---	---	---	---	---	---	---	---	---	---	---
10	12.00	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.87	---	DS	0.03	35	---	---	---	
10	15.00	SPT	Silty fine sand	100	100	99.37	98.14	91.82	59.86	13.11	0	87	13	0	---	---	NP	---	SM	2.64	---	---	---	---	---	---	---	---	---	---	---
10	21.00	SPT	Silty fine sand	100	100	100	97.70	94.02	51.71	9.28	0	91	9	0	---	---	NP	---	SM	2.64	---	---	---	---	---	---	---	---	---	---	---
11	3.00	SPT	Silty fine sand	97.88	97.25	96.29	95.05	90.36	54.74	16.72	2	81	17	0	---	---	NP	---	SM	2.62	---	---	---	---	---	---	---	---	---	---	---
11	4.50	SPT	Silty fine sand	100	99.78	99.49	98.42	90.54	49.19	15.08	0	85	15	0	---	---	NP	---	SM	2.65	---	---	---	---	---	---	---	---	---	---	---

UDS = Undisturbed Soil Sample, SPT = Standard Penetration Test, DS = Direct Shear Test, NP = Non Plastic.

Annexure - IV
Laboratory Test Result on Soil Sample

BoreHole No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test				
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)		
11	7.50	SPT	Silty fine sand	100	100	99.11	96.76	90.59	52.66	12.78	0	87	13	0	---	---	NP	---	SM	2.63	---	---	---	---	---	---	---	---	---	---
11	13.50	SPT	Silty fine sand	100	100	98.97	97.28	91.92	61.66	25.07	0	75	25	0	---	---	NP	---	SM	2.65	---	---	---	---	---	---	---	---	---	---
11	15.00	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.81	---	DS	0.05	32	---	---	---
11	18.00	SPT	Silty fine sand	100	99.78	98.16	95.81	91.12	56.43	21.17	0	79	21	0	---	---	NP	---	SM	2.66	---	---	---	---	---	---	---	---	---	---
11	24.00	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.85	---	DS	0.03	35	---	---	---
12	3.00	SPT	Silty fine sand	100	100	100	99.25	97.89	68.69	23	0	77	23	0	---	---	NP	---	SM	2.64	---	---	---	1.86	---	DS	0.05	34	---	---
12	6.00	SPT	Silty fine sand	100	99.86	99.14	97.56	95.68	59.86	20	0	80	20	0	---	---	NP	---	SM	2.63	---	---	---	1.84	---	DS	0.04	34	---	---
12	10.50	SPT	Silty fine sand	100	98.68	97.15	95.86	92.54	55.86	17	0	83	17	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---	---	---
12	18.00	SPT	Silty fine sand	100	99.24	97.89	95.22	90.86	49.86	15	0	85	15	0	---	---	NP	---	SM	2.61	---	---	---	---	---	---	---	---	---	---
13	1.50	SPT	Silty fine sand	100	100	99.45	97.76	94.51	61.23	23.95	0	76	24	0	---	---	NP	---	SM	2.66	---	---	---	---	---	---	---	---	---	---
13	3.00	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.80	---	DS	0.07	32	---	---	---
13	4.50	SPT	Silty fine sand	100	100	99.80	99.35	94.09	55.32	26.18	0	74	26	0	---	---	NP	---	SM	2.63	---	---	---	---	---	---	---	---	---	---

UDS = Undisturbed Soil Sample, SPT = Standard Penetration Test, DS = Direct Shear Test, NP = Non Plastic.

Annexure - IV
Laboratory Test Result on Soil Sample

BoreHole No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test					
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)			
13	9.00	SPT	Silty fine sand	100	100	100	100	99.76	73.52	19.26	0	81	19	0	---	---	NP	---	SM	2.65	---	---	---	---	---	---	---	---	---	---	---
13	12.00	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.83	---	DS	0.04	34	---	---	---	---
13	15.00	SPT	Silty fine sand	100	99.54	99.16	98.34	97.00	47.42	17.94	0	82	18	0	---	---	NP	---	SM	2.64	---	---	---	---	---	---	---	---	---	---	---
13	19.50	SPT	Silty fine sand	100	100	98.75	96.06	89.07	48.87	15.79	0	84	16	0	---	---	NP	---	SM	2.63	---	---	---	---	---	---	---	---	---	---	---
14	1.50	SPT	Silty fine sand	100	100	99.68	99.16	94.56	58.64	22.76	0	77	23	0	---	---	NP	---	SM	2.67	---	---	---	---	---	---	---	---	---	---	---
14	3.00	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.82	---	DS	0.05	33	---	---	---	---
14	4.50	SPT	Silty fine sand	100	100	99.00	98.11	92.56	52.27	16.05	0	84	16	0	---	---	NP	---	SM	2.63	---	---	---	---	---	---	---	---	---	---	---
14	7.50	SPT	Silty fine sand	100	100	100	99.19	91.31	52.40	18.10	0	82	18	0	---	---	NP	---	SM	2.64	---	---	---	---	---	---	---	---	---	---	---
14	13.50	SPT	Silty fine sand	97.80	97.47	96.91	95.66	85.40	48.51	10.07	2	88	10	0	---	---	NP	---	SM	2.58	---	---	---	---	---	---	---	---	---	---	---
15	1.50	SPT	Silty fine sand	100	100	99.80	98.81	95.27	62.01	23.91	0	76	24	0	---	---	NP	---	SM	2.67	---	---	---	---	---	---	---	---	---	---	---
15	4.50	SPT	Silty fine sand	100	100	98.38	97.15	88.23	58.38	20.96	0	79	21	0	---	---	NP	---	SM	2.66	---	---	---	---	---	---	---	---	---	---	---
15	6.00	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.87	---	DS	0.04	35	---	---	---	---

UDS = Undisturbed Soil Sample, SPT = Standard Penetration Test, DS = Direct Shear Test, NP = Non Plastic.

Annexure - IV
Laboratory Test Result on Soil Sample

BoreHole No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test					
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)			
15	7.50	SPT	Silty fine sand	100	99.48	97.88	95.29	83.17	52.19	16.81	0	83	17	0	---	---	NP	---	SM	2.64	---	---	---	---	---	---	---	---	---	---	---
15	13.50	SPT	Silty fine sand	98.95	98.70	97.42	94.42	86.65	51.03	13.03	1	86	13	0	---	---	NP	---	SM	2.62	---	---	---	---	---	---	---	---	---	---	---
15	18.00	SPT	Silty fine sand	100	100	98.78	93.16	85.16	53.91	10.80	0	89	11	0	---	---	NP	---	SM	2.63	---	---	---	---	---	---	---	---	---	---	---
15	21.00	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.84	---	DS	0.04	33	---	---	---	---
16	1.50	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.85	---	DS	0.03	34	---	---	---	---
16	3.00	SPT	Silty fine sand	100	100	99.01	96.81	90.31	60.01	13.96	0	86	14	0	---	---	NP	---	SM	2.64	---	---	---	---	---	---	---	---	---	---	---
16	4.50	SPT	Silty fine sand	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.81	---	DS	0.07	32	---	---	---	---
16	6.00	SPT	Silty fine sand	100	100	100	97.95	95.97	67.03	20.07	0	80	20	0	---	---	NP	---	SM	2.64	---	---	---	---	---	---	---	---	---	---	---
16	10.50	SPT	Silty fine sand	100	100	100	99.98	99.86	84.00	24.18	0	76	24	0	---	---	NP	---	SM	2.65	---	---	---	---	---	---	---	---	---	---	---
16	13.50	SPT	Silty fine sand	100	100	100	100	99.51	51.95	15.69	0	84	16	0	---	---	NP	---	SM	2.66	---	---	---	---	---	---	---	---	---	---	---
16	19.50	SPT	Silty fine sand	99.08	98.86	97.54	96.95	94.59	49.39	9.51	1	89	10	0	---	---	NP	---	SM	2.62	---	---	---	---	---	---	---	---	---	---	---
17	1.50	SPT	Silty fine sand	100	100	100	99.56	97.86	66.25	21	0	79	21	0	---	---	NP	---	SM	2.66	---	---	---	1.80	---	DS	0.08	32	---	---	---

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Annexure - IV
Laboratory Test Result on Soil Sample

BoreHole No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test		
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)
17	3.00	SPT	Silty fine sand	100	100	99.46	98.35	94.26	57.59	17	0	83	17	0	---	---	NP	---	SM	2.63	---	---	---	1.83	---	DS	0.06	33
17	6.00	SPT	Silty fine sand	99	98.14	97.43	95.86	92.68	59.86	11	1	88	11	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
17	9.00	SPT	Silty fine sand	98	97.22	96.28	94.44	90.86	54.68	9	2	89	9	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
18	3.00	SPT	Silty fine sand	100	100	99.86	99.24	96.88	67.86	16	0	84	16	0	---	---	NP	---	SM	2.66	---	---	---	1.79	---	DS	0.07	32
18	6.00	SPT	Silty fine sand	99	98.45	97.16	95.86	92.89	62.86	13	1	86	13	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
18	10.50	SPT	Silty fine sand	98	97.24	95.86	94.11	92.24	57.59	10	2	88	10	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
21	4.50	SPT	Silty fine sand	100	99.57	98.75	96.86	94.68	54.56	19	0	81	19	0	---	---	NP	---	SM	2.62	---	---	---	1.85	---	DS	0.03	35
21	9.00	SPT	Silty fine sand	100	99.87	97.89	95.86	94.12	50.78	21	0	79	21	0	---	---	NP	---	SM	---	---	---	---	1.82	---	DS	0.09	32
21	15.50	SPT	Silty fine sand	100	99.34	97.86	96.22	94.86	51.24	14	0	86	14	0	---	---	NP	---	SM	2.64	---	---	---	---	---	---	---	---
21	18.00	SPT	Silty fine sand	100	98.89	97.46	95.86	92.86	54.56	12	0	88	12	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
22	1.50	SPT	Clayey silt	100	100	100	99.62	98.95	97.72	96.11	0	4	81	15	42	21	21	---	CI	2.68	11.5	---	---	---	---	---	---	---
22	4.00	UDS	Clayey silt	100	100	100	100	100	98.86	96.06	0	4	80	16	45	24	21	---	CI	2.67	12	---	1.39	1.96	41.25	UU	0.22	5

UDS = Undisturbed Soil Sample, SPT = Standard Penetration Test, DS = Direct Shear Test, NP = Non Plastic.

Annexure - IV
Laboratory Test Result on Soil Sample

BoreHole No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test		
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)
22	7.50	SPT	Silty fine sand	98.76	98.38	97.15	95.46	86.58	46.30	9.42	1	90	9	0	---	---	NP	---	SM	2.60	---	---	---	---	---	---	---	---
22	15.00	SPT	Silty fine sand	97.91	97.22	95.62	92.63	84.83	46.06	7.16	2	91	7	0	---	---	NP	---	SM	2.61	---	---	---	---	---	---	---	---
22	18.00	SPT	Silty fine sand	97.02	95.80	94.50	90.94	80.32	45.06	6.08	3	91	6	0	---	---	NP	---	SM	2.60	---	---	---	---	---	---	---	---
23	1.50	SPT	Silty fine sand	100	100	100	99.45	98.86	72.56	25	0	70	25	5	---	---	NP	---	SM	2.59	---	---	---	1.79	---	DS	0.10	31
23	3.00	SPT	Silty fine sand	100	99.86	99.15	98.42	94.86	62.86	18	0	82	18	0	---	---	NP	---	SM	2.63	---	---	---	1.86	---	DS	0.05	34
23	6.00	SPT	Silty fine sand	99	97.86	95.89	94.68	92.89	54.26	10	1	89	10	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
24	4.50	SPT	Silty fine sand	100	100	100	99.57	97.89	56.68	22	0	78	22	0	---	---	NP	---	SM	2.62	---	---	---	1.81	---	DS	0.06	33
24	10.50	SPT	Silty fine sand	100	98.86	96.86	94.86	92.22	52.26	15	0	85	15	0	---	---	NP	---	SM	2.61	---	---	---	1.84	---	DS	0.03	34
24	16.50	SPT	Silty fine sand	100	99.24	97.86	94.86	91.68	49.86	12	0	88	12	0	---	---	NP	---	SM	2.59	---	---	---	---	---	---	---	---
25	3.00	SPT	Silty fine sand	100	100	99.86	99.26	98.26	70.25	20	0	80	20	0	---	---	NP	---	SM	2.57	---	---	---	1.80	---	DS	0.07	31
25	6.00	SPT	Silty fine sand	100	99.24	97.86	96.24	93.87	54.56	17	0	83	17	0	---	---	NP	---	SM	2.62	---	---	---	1.87	---	DS	0.03	35
25	9.00	SPT	Silty fine sand	99	98.24	96.86	94.78	91.86	49.68	10	1	89	10	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---

UDS = Undisturbed Soil Sample, SPT = Standard Penetration Test, DS = Direct Shear Test, NP = Non Plastic.

Annexure - V
Laboratory Test Result on Rock Sample

BoreHole No.	Depth (m.)	Sample Type	Density (gm/cc)	Specific Gravity	Water Content (%)	Porosity (%)	UCS (kg/sq.cm) (Saturated)	Point Load Strength Index	Slake Durability Index (%)	Hardness	Deformability (Mpa)
1	12.00-13.50	Core	2.34	2.87	11.23	15.34	158.86	3.70	20.2	7.0	120
1	13.50-15.00	Core	2.11	2.64	12.25	20.12	---	1.20	8.2	2.5	40
1	15.00-16.50	Core	2.26	2.79	8.46	18.46	152.24	3.20	17.9	7.0	---
1	18.00-19.50	Core	2.22	2.87	9.64	17.42	123.24	2.40	18.5	7.0	---
3	16.50-18.00	Core	2.31	2.61	7.49	18.16	130.46	2.30	19.2	7.0	100
3	19.50-21.00	Core	2.28	2.84	11.58	14.36	145.65	3.40	18.8	7.0	110
3	21.00-22.50	Core	2.37	2.86	12.86	17.55	134.58	3.10	16.8	7.0	---
3	24.00-25.00	Core	2.39	2.61	11.37	19.24	---	1.90	8.6	2.5	30
4	16.50-18.00	Core	2.28	2.58	10.46	13.54	---	2.20	8.7	2.5	20
4	18.00-19.50	Core	2.31	2.63	6.56	16.86	---	2.60	9.4	2.5	---
6	9.00-10.50	Core	2.42	2.68	8.24	16.14	122.58	3.80	17.4	6.5	---
6	12.00-13.50	Core	2.17	2.67	11.86	15.42	---	2.90	9.1	2.5	30
6	15.00-16.50	Core	2.27	2.68	9.75	12.89	124.75	3.20	16.8	6.5	---
6	18.00-19.50	Core	2.46	2.82	8.12	17.46	140.58	4.30	18.2	7.0	120
7	9.00-10.50	Core	2.16	2.58	13.26	20.14	---	2.40	8.7	2.5	---

Annexure - V
Laboratory Test Result on Rock Sample

BoreHole No.	Depth (m.)	Sample Type	Density (gm/cc)	Specific Gravity	Water Content (%)	Porosity (%)	UCS (kg/sq.cm) (Saturated)	Point Load Strength Index	Slake Durability Index (%)	Hardness	Deformability (Mpa)
7	10.50-12.00	Core	2.22	2.66	11.24	14.55	---	2.90	8.2	2.5	40
7	12.00-13.50	Core	2.29	2.74	8.47	16.27	112.26	3.10	17.7	6.5	---
7	15.00-16.50	Core	2.48	2.75	9.68	13.87	131.24	3.80	16.8	7.0	100
14	9.23-10.50	Core	2.33	2.74	14.12	18.89	138.54	3.90	15.5	6.5	110
14	19.50-21.00	Core	2.18	2.61	12.34	17.57	---	1.90	8.6	2.5	---
14	24.00-25.00	Core	2.31	2.57	10.56	14.62	---	1.80	9.4	2.5	30
17	16.50-18.00	Core	2.29	2.60	6.68	9.86	---	1.68	9.5	2.5	40
17	18.00-19.50	Core	2.21	2.68	7.86	10.24	127.89	2.70	18.4	6.5	---
17	21.00-22.50	Core	2.19	2.57	8.36	12.11	132.46	3.10	19.2	6.5	---
17	22.50-24.00	Core	2.31	2.76	9.86	13.51	138.49	3.40	16.8	6.5	110
18	16.50-18.00	Core	2.39	2.84	10.55	14.64	---	2.20	8.8	2.5	---
18	18.00-19.50	Core	2.27	2.64	11.76	15.27	128.45	2.70	18.2	6.5	---
18	19.50-21.00	Core	2.22	2.69	12.56	18.33	---	2.30	8.2	2.5	30
18	21.00-22.50	Core	2.39	2.71	11.24	17.49	119.86	2.90	17.4	6.5	90
18	22.50-24.00	Core	2.46	2.88	10.31	15.26	131.56	3.80	16.6	6.5	---

Annexure - V
Laboratory Test Result on Rock Sample

BoreHole No.	Depth (m.)	Sample Type	Density (gm/cc)	Specific Gravity	Water Content (%)	Porosity (%)	UCS (kg/sq.cm) (Saturated)	Point Load Strength Index	Slake Durability Index (%)	Hardness	Deformability (Mpa)
23	16.50-18.00	Core	2.18	2.69	8.56	12.35	---	2.20	8.7	2.5	---
23	18.00-19.50	Core	2.27	2.78	9.76	17.11	---	1.75	9.5	2.5	30
23	19.50-21.00	Core	2.26	2.66	14.52	19.25	129.86	3.10	15.7	6.5	---
23	22.50-24.00	Core	2.12	2.64	10.26	15.34	135.65	3.40	15.4	6.5	120
25	15.10-16.50	Core	2.26	2.82	5.89	8.56	---	2.10	9.1	2.5	20
25	18.00-19.50	Core	2.35	2.69	7.68	10.78	---	2.70	8.4	2.5	40

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

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CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

Annexure – VI**Result of Water Sample Analysis**

BH No.	pH	Turbidity	Specific Conductivity at 25 ⁰ C	Cl (ppm)	SO ₃ (ppm)	SO ₄ (ppm)	Carbonate (ppm)	Nitrate (ppm)	Organic matter (mg/l)
BH – 3	6.67	2.8	402.5	11.9	3.6	4.9	Nil	1.20	80
BH – 6	6.89	3.9	453.6	13.7	4.1	4.4	Nil	1.29	69
BH – 12	6.84	3.3	351.5	11.5	3.9	4.7	Nil	1.24	62
BH – 14	6.92	5.5	515.6	13.4	4.2	5.1	Nil	1.35	88
BH – 16	6.74	4.2	527.6	12.2	3.4	5.3	Nil	1.31	74

Physical Test Finding: 1. Colour – Colourless, 2. Odour - Agreeable

Result of Soil Sample Analysis

BH No.	pH	Cl (%)	SO ₃ (%)	SO ₄ (%)	Carbonate (%)	Nitrate (%)	Organic matter (%)	Chemical Salinity (mg/cm)
BH – 8	7.25	0.018667	0.001606	0.001935	14.32	0.00003	0.83	0.0515
BH – 9	7.34	0.017564	0.001645	0.001924	13.56	0.00002	0.87	0.0756
BH – 21	7.49	0.015864	0.001715	0.002046	12.46	0.00002	0.94	0.0612
BH – 17	7.58	0.167846	0.001669	0.002108	14.86	0.00003	1.16	0.0549
BH – 23	7.56	0.014656	0.001753	0.002112	13.77	0.00003	1.50	0.0960

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Annexure – VII**Computation of Safe Bearing Capacity for Shallow Foundation for BH – 9**

An isolated foundation of 6.50 m x 8.125 m at a depth of 2.00 m below EGL is considered.

Use, $\Phi = 28 + 15 \times D_r$. [In absence of any codal reference]

[Ref: "Foundation Analysis and Design", Fifth Edition, by J.E.Bowles, Table: 3-4, PP-162.]

Relative density = 23.33 %.

Method of analysis = Interpolation between general shear and local shear.

DETERMINATION OF BEARING CAPACITY:

The Net Ultimate Bearing Capacity is given as (As per IS 6403):

$$q_d = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma W'$$

Where,

N_c , N_q and N_γ are bearing capacity factors,

S_c , S_q and S_γ are shape factors,

d_c , d_q and d_γ are depth factors,

And

C = Cohesion

q = Effective surcharge at the base level of foundation,

B = Width of foundation,

γ = Bulk Density below foundation.

W' = Correction factor for location of water table.

Considering general shear:

Relative density = 70.00 %. Corresponding $\Phi = 39^\circ$

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Cohesion, C =	0.00	kg/cm ²		
Friction Angle, Φ =	39	°		
Depth of Foundation, D_f =	2.00	m		
Width of Foundation., B =	6.50	m		
Submerged Density, γ =	0.90	t/m ³		
Water table correction =	0.50			
L/B ratio =	1.25			
FOS =	3.00			
N_c =	69.47	N_q =	58.02	N_γ = 97.13
D_c =	1.13	D_q =	1.06	D_γ = 1.06
S_c =	1.16	S_q =	1.16	S_γ = 0.68
Computed Net Ultimate Bearing Capacity =		343.83	t/m ²	
So, we have Net Safe Bearing Capacity =		114.61	t/m ²	

Considering local shear:

Relative density = 20.00 %. Corresponding $\Phi = 31^\circ$

Using $\Phi = \tan^{-1}\{(2/3) \times \tan 31\} = 22^\circ$,

Cohesion, C =	0.00	kg/cm ²		
Friction Angle, Φ =	22	°		
Depth of Foundation, D_f =	2.00	m		
Width of Foundation., B =	6.50	m		
Submerged Density, γ =	0.75	t/m ³		
Water table correction =	0.50			
L/B ratio =	1.25			
FOS =	3.00			
N_c =	17.19	N_q =	8.10	N_γ = 7.59
D_c =	1.09	D_q =	1.05	D_γ = 1.05
S_c =	1.16	S_q =	1.16	S_γ = 0.68
Computed Net Ultimate Bearing Capacity =		28.26	t/m ²	
So, we have Net Safe Bearing Capacity =		9.42	t/m ²	

Interpolated net safe bearing capacity = $9.42 + \{[(114.61 - 9.42)/(39 - 31)] \times (31.50 - 31)\}$
= **16.00 t/m²**

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Annexure – VIII**Computation of Settlement Calculation for BH – 9**

Width of foundation = 6.50 m Length of foundation = 8.13 m
D = Depth of foundation = 2.00 m below existing ground level
Influence zone for settlement of foundation = 13.00 m below founding level
Safe bearing capacity = 16 t/m²
Foundation pressure = 16 t/m²

Immediate Settlement:

Design corrected N = 14

At 10 t/m² pressure, settlement for foundation = 25.00 mm

[Ref: Fig-9 of IS: 8009 (Part-I)]

Water table correction = 0.50 (Considering ground water level at ground level)

So the corrected settlement = 50.00 mm

S_i = 80.00 mm

Most of the immediate settlement will occur during construction period, However, 50% of the immediate settlement is considered.

Applying correction for depth factor,

Corrected S_i = 30.40 mm

D/(L x B)^{0.5} = 0.2752 Corresponding depth factor = 0.95

[Ref: Fig 12 of IS 8009 (Part I)]

Rigidity Factor 0.80 *[Ref: Cl. No. 9.5.2 of IS 8009 (Part I)]*

Considering permissible settlement, = 25.00 mm

Recommended allowable bearing capacity = 15.00 t/m²

Final settlement = 28.50 mm

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Annexure – IX**Sample Computation of Allowable Pile Capacity for BH – 9****Sample Calculation for Safe Vertical Pile Capacity**

Safe load bearing capacities of pile has been conducted based on following considerations.

- a) Cut-off level shall be based on site condition & technological consideration
- b) Pile capacities estimated following IS 2911 (Part 1/Sec 2): 2010
- c) Grade of Concrete = M30
- d) Diameter of pile = 760 mm

Design Strength Parameters:**STRATUM – II:**

Use, design $C = 0.00 \text{ kg/cm}^2$ & $\Phi = 31.50^\circ$.

$$\gamma_{\text{sat}} = 1.80 \text{ t/m}^3. \gamma_{\text{sub}} = 0.80 \text{ t/m}^3 [\text{Effective density}]$$

STRATUM – III:

Use, design $C = 0.00 \text{ kg/cm}^2$ and $\Phi = 33.00^\circ$.

$$\gamma_{\text{sat}} = 1.85 \text{ t/m}^3. \gamma_{\text{sub}} = 0.85 \text{ t/m}^3 [\text{Effective density}]$$

Ultimate vertical capacity of bored cast in situ RCC pile in soil may be estimated using the formula given below: [As per IS 2911 (Part 1/Sec 2): 2010]

$$Q_u = (A_p \times P_D \times N_q) + (A_p \times N_c \times C_p) + \sum [K_i \times P_{Di} \times \tan \delta_i \times A_{si}] + \sum [\alpha_i \times c_i \times A_{si}]$$

where,

Q_u = Ultimate vertical load carrying capacity of RCC bored pile,

A_p = Cross sectional area of pile tip. $= \pi/4 \times (D)^2$

D = Diameter of pile.

P_D = Effective overburden pressure at pile tip.

N_q = Bearing capacity factor for bored pile depending on Φ .

N_c = Bearing capacity factor, may be taken as 9.

C_p = Average cohesion at pile tip.

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K_i = Co-efficient of earth pressure in i^{th} layer.

P_{Di} = Effective overburden pressure at the mid-depth of i^{th} layer.

δ_i = Angle of wall friction between pile and soil for the i^{th} layer.

A_{si} = Surface area of pile shaft in i^{th} layer = $\pi \times D \times L_i$

L_i = Length of pile in respective stratum,

Φ = Angle of internal friction of soil.

α_i = Adhesion factor for the i^{th} layer.

C_i = Average cohesion for the i^{th} layer.

Sample Calculation of Safe Vertical Pile Capacity (Around BH – 9) [As per IS 2911**(Part 1/Sec 2): 2010]**

Pile terminating depth below existing ground level = 20.00 m.

Cut-off depth = 2.00 m below existing ground level.

Liquefaction depth = 5.00 m below existing ground level.

Shaft length contributing pile capacity = 15.00 m.

Diameter of pile = 760 mm.

Calculation of lateral pile capacity around BH – 9 (Fixed head)

Design "N" =	14		
Cantilever length(L_1) =	300	cm	
Dia of pile =	760	mm	
f_{ck} of concrete =	30	MPa	
Deflection =	5	mm	(At liquefaction potential depth level)
h =	0.24	Kg/cucm	Modulus of Subgrade reaction
Moment of inertia (I) =	1637660.60	cm ⁴	
E of concrete =	27386.13	N/sqmm	273861.28 Kg/sqcm
T =	285.82	cm	
L_1/T =	1.05		
Factor for calculating L_f =	2.00		
L_f =	572.22	cm	
Pile head deflection Y =	0.12	cm	1.2329503 mm
Deflection at cut-off level =	7.62	mm	
Moment =	4.36	t-m per t of Thrust	
Reduction Factor =	0.92		
H =	6.18	t	
Corrected actual moment =	4.03	t-m per t of Thrust	

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Bottom depth of Pile =	20.00	m below existing ground level.		
Cut-off Length =	2.00	m below existing ground level.		
Liquefaction Depth =	5.00	m below existing ground level.		
Diameter of Pile =	760	mm	Critical depth	17.00 D
FOS of Shaft Resistance =	2.50		*Max unit friction on shaft f_s	10 t/m^2
FOS for End Bearing =	2.50		*Maximum $q(\text{tip}) =$	500 t/m^2
So, maximum Depth upto which pressure will increase =	12.92	m	Maximum OVP =	10.86 t/m^2
(Below liquefaction potential depth)				

Layer No.	Top Depth (m)	Bottom Depth (m)	Eff. Depth (m)	Cohesion (kg/cm^2)	Φ (Degree)	Adhesion Factor (α)	K_0	Eff. Density (t/m^3)	Mean Pressure (t/m^2)
II	5.00	7.50	2.50	0.00	31.5	1.000	1.08	0.80	1.00
III	7.50	20.00	12.50	0.00	33	1.000	1.15	0.85	7.17

Layer No.	Eff. Depth (m)	Effective σ_z (t/m^2)	$f_{s1} = \alpha C$	$f_{s2} = K_0 \sigma_z \tan \Phi$	$f_s = f_{s1} + f_{s2}$ (t/m^2)	Ultimate Shaft Resistance (t)	Safe Shaft Resistance (t)
II	2.50	1.00	0.00	0.66	0.66	3.93	1.57
III	12.50	7.17	0.00	5.35	5.35	159.71	63.88
	15.00					163.64	65.46

For End Bearing

Cohesion $C =$ 0 kg/cm^2
Friction Angle = 33 °

Uplift Pile Capacity:

Uplift capacity = $1/3 \times [(\text{Shaft Resistance in Vertical Capacity}) + \text{self weight of pile (Buoyant)}]$
= 56.59 t

$N_q =$ 35.45
Eff. Ovp. Pressure = $p(\text{tip})$ 10.86 t/m^2
 $q(\text{tip}) = p(\text{tip}) \cdot N_q =$ 384.89 t/m^2
Ultimate End Bearing = 174.60 t
Safe End Bearing = 69.84 t
Safe Shaft Resistance = 65.46 t

So, Recommended Uplift Pile Capacity = 46 t.

So, Total Pile Capacity = 135.30 t
Self weight of pile (Buoyant) = 6.12 t

** Note: As per "Pile Design and Construction Practice, Fourth Edition"
by M.J. Tomlinson, Page-119 & 122*

So, Recommended Vertical Pile Capacity = 125 t

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Annexure – X

Recommendation of Stone Column

1. Introduction

The project site is located in a seismic region with predominantly loose to medium dense sandy soil and a shallow groundwater table. In such soils, there is a high potential for liquefaction during earthquakes and low bearing capacity under static loading. This report provides the design for stone column installation as per the Indian Standard IS 15284 (Part - 1): 2003 to achieve ground improvement.

2. Site Description and Soil Conditions

Location: Great Nicobar

BH location: BH 4 (E 593200, N 755180)

Soil Type: Loose, clean, saturated fine Silty Sand

Depth of soft Layer: 0 to 7.5 m

Groundwater Table: Near to the ground surface

SPT (N) Values: 13 to 17

Seismic Zone: Zone V [IS 1893 (Part – 1): 2016]

Liquefiable Soil Layer: 0 to 7.5 m [IS 1893 (Part – 1): 2016]

Recommended depth of Stone Column: 9 to 10 m, from 1 m below NGL.

3. Problem Statement

The site consists of saturated sandy soil, susceptible to liquefaction under seismic loading. Additionally, the bearing capacity of the soil is insufficient to support the planned superstructure.

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4. Stone Column Technology Overview

Stone columns are vertical inclusions made by replacing soil with compacted gravel or crushed stone. They:

- Increase shear strength
- Provide drainage paths to dissipate pore water pressure
- Reduce settlement
- Improve bearing capacity

5. Objectives of Ground Improvement

- Increase allowable bearing capacity to ≥ 100 kPa
- Reduce total and differential settlements
- Prevent liquefaction during seismic events
- Improve soil stiffness and shear strength

6. Design Approach Based on IS 15284 (Part 1) : 2003

6.1 Design Parameters:

Diameter of Stone Column (D): 0.8 m (Assume)

Group Stone column arrangement: Triangular [IS 15284 (Part – 1):2003, Figure 1 & 5]

Effective Diameter of Column (D_e): $1.05S$ [IS 15284 (Part – 1):2003, Section 7.4]

So, $D_e = 0.84$ m

Spacing (S): 2.0 m in equilateral triangular pattern [IS 15284 (Part – 1):2003, Subsection 7.3.1, Page 2]

Length (L): 10 m

Area Replacement Ratio (a_s):

$a_s = A_s / A = A_s / (A_s + A_g)$ or $a_s = 0.907(D/S)^2$ [IS 15284 (Part – 1):2003, Section 7.5]

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So, $a_s = 2.32$

A_s = area of the stone column,

A_g = area of ground surrounding the column, and

A = total area within the unit cell.

6.2 Bearing Capacity Estimation [IS 15284 (Part – 1):2003, Annex A]:

$$\gamma = 1.84 \text{ gm/cm}^3$$

$$z = 2D = 2 \times 0.8 = 1.60 \text{ m} = 160 \text{ cm}$$

Angle of internal friction of soil = $\Phi_g = 30^\circ$ [From laboratory test data]

Angle of internal friction of granular column material = $\Phi_c = 40^\circ$ [IS 15284 (Part – 1):2003, Annex A]

$$K_p = (1 + \sin\Phi_g / 1 - \sin\Phi_g) = (1 + \sin 30^\circ / 1 - \sin 30^\circ) = 2$$

Passive earth pressure for soil, $\sigma_{rL} = 5.89 \text{ t/m}^2$ [IS 15284 (Part – 1):2003, Annex A]

$$\sigma_v (\text{shear failure due to bulging}) = \sigma_{rL} \cdot K_{p_{\text{cool}}} \text{ [IS 15284 (Part – 1):2003, Annex A]}$$

$$= \sigma_{rL} \cdot (1 + \sin 40^\circ / 1 - \sin 40^\circ)$$

$$= 27.10 \text{ t/m}^2$$

$$\text{Safe load on column, } Q_1 = \sigma_v (\pi/4) (D^2 / 2) \text{ [IS 15284 (Part – 1):2003, Annex A]}$$

$$= 27.23 \text{ t}$$

Recommended Safe load on column = 25 t

6.3 Granular Blanket

A blanket need to provide over the top of the stone columns should consist of clean medium to coarse sand compacted in layers to a relative density of 75 to 80 %. With a minimum thickness of the compacted sand blanket should be 0.5 m [IS 15284 (Part – 1):2003, Section 13].



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6.4 Settlement

The actual settlement of the Stone column must be evaluated by constructing Initial test column, for the recommended load under field conditions, following the procedure outlined in IS 15284 (Part 1): 2003, Section 13.

7. Construction Methodology

It is recommended to use the vibro-displacement method for forming ground improvement columns, as it effectively enhances soil strength and stability. Gravel or stone aggregate should be introduced using the bottom-feed technique to ensure precise and controlled placement at depth. Compaction should be performed in successive lifts to achieve uniform density and improve column integrity. Additionally, continuous field monitoring is advised to maintain the required diameter and verticality of the columns, ensuring consistent quality and performance throughout the installation process.

8. Conclusion

Based on IS 15284 (Part 1): 2003, the design of stone columns presented here effectively improves soil performance for the given site conditions, with a bearing capacity of 25t/m². Before final construction, Stone column must be evaluated by constructing Initial test column, for the recommended load under field conditions, following the procedure outlined in IS 15284 (Part 1):2003, Section 13.

****Note:** The stone column has been recommended as per IS 15284 (Part 1):2003, Section 13 and Nptelhrd. (2012, October 4).

References

- IS 15284 (Part 1): 2003 – *Design and Construction for Ground Improvement – Guidelines – Stone Columns*
- IS 1893 (Part 1): 2016 – *Seismic Design Code*
- Nptelhrd. (2012, October 4). Mod-03 Lec-09 Case studies in stone columns [Video file]. etrieved from <https://www.youtube.com/watch?v=TJRWW3cNmCQ>



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Annexure – XI Field Photographs



Rev. 01

Geotechnical Investigation Report



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Annexure – XII Laboratory Photographs



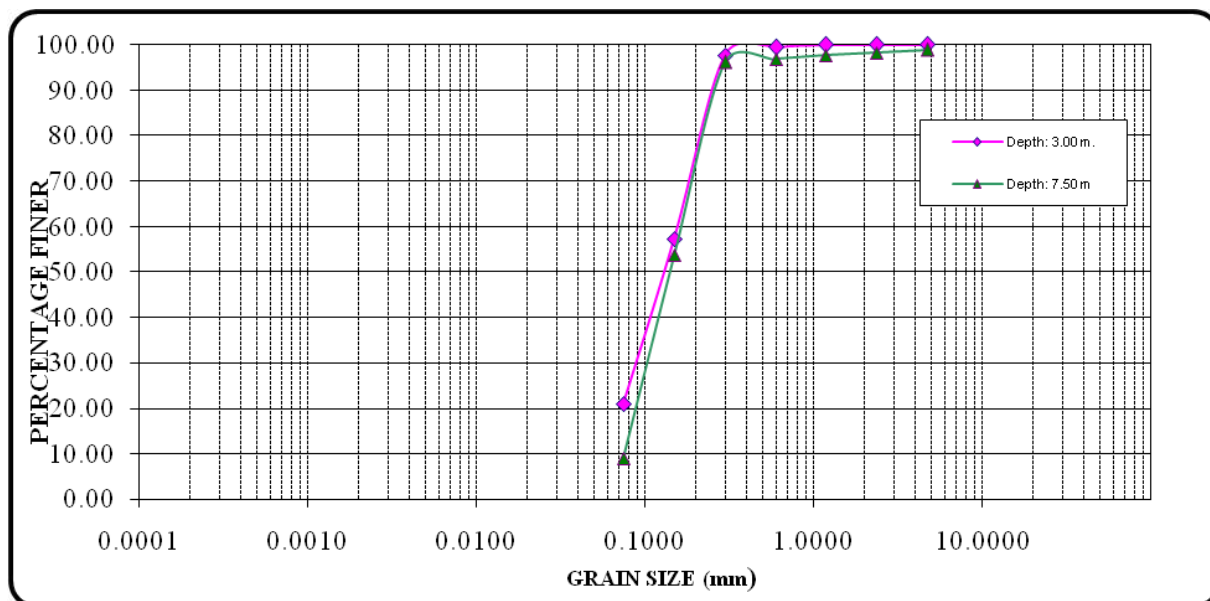


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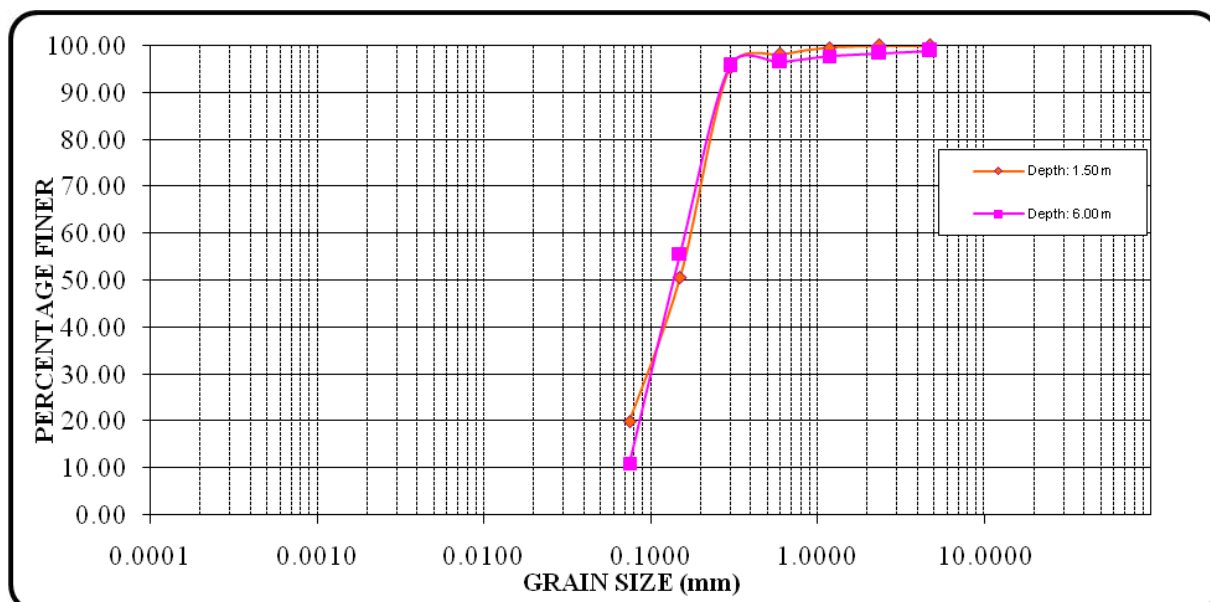
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Annexure – XIII Grain Size Distribution Curves

i) BH – 1



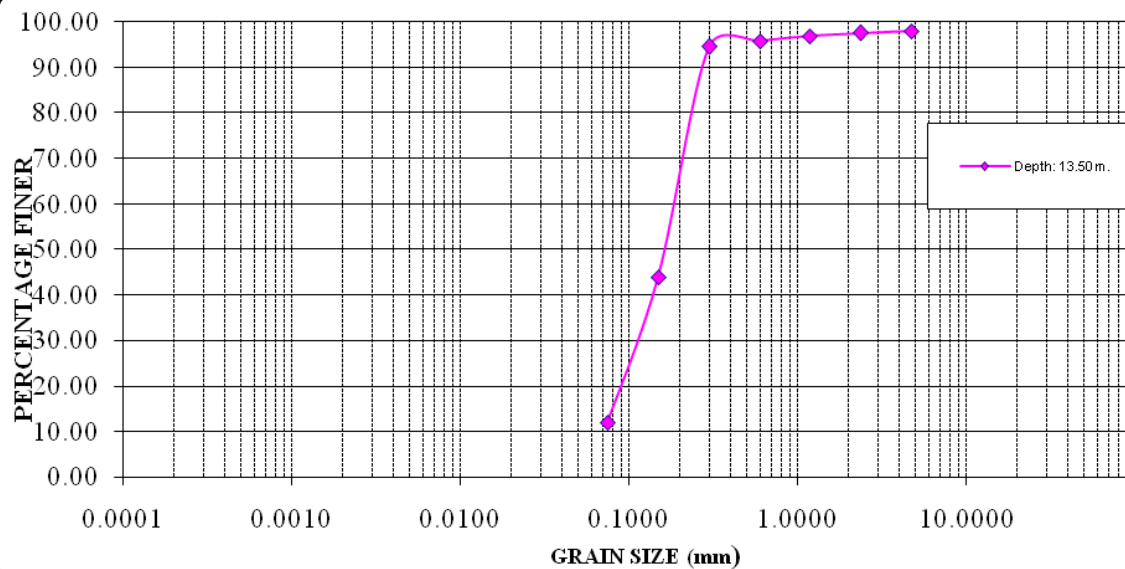
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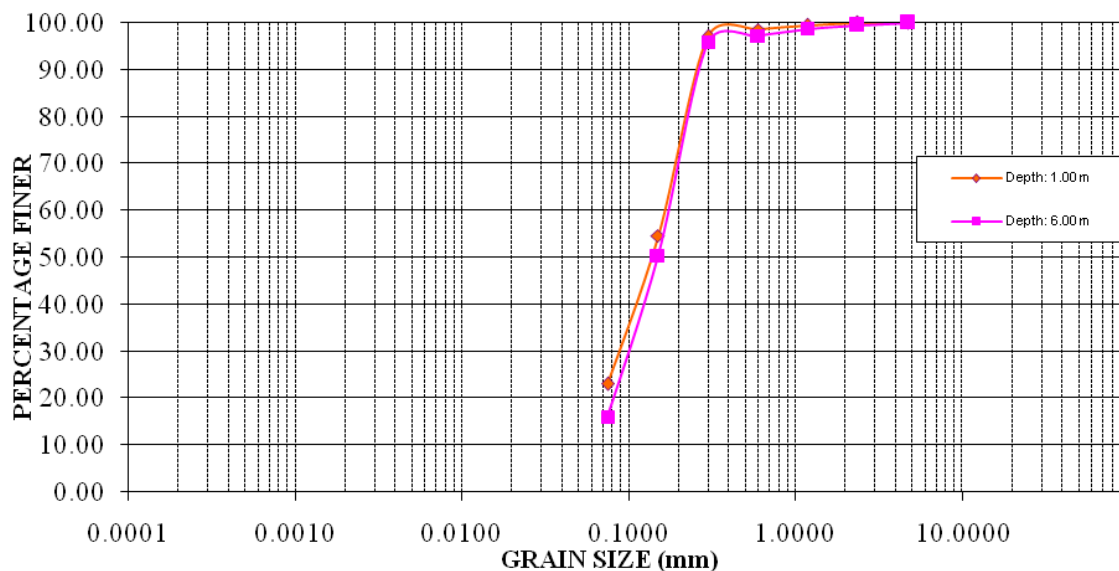


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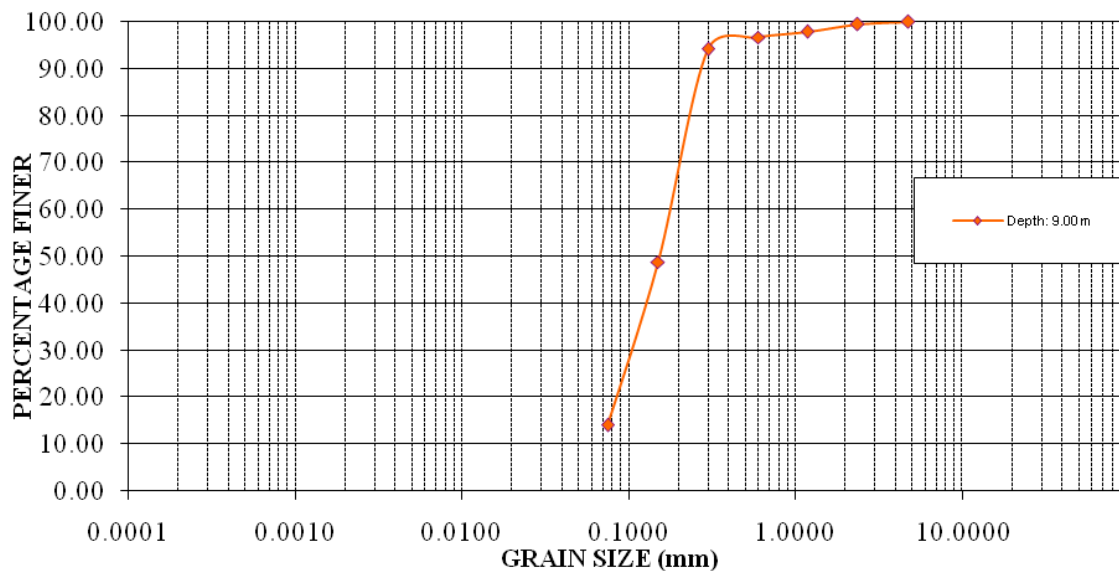
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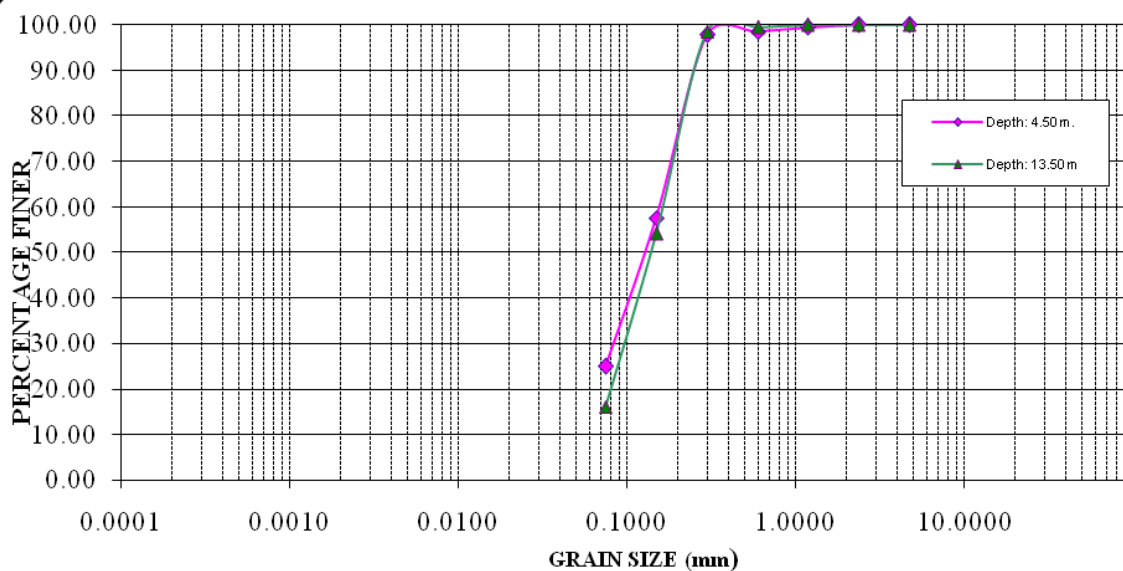


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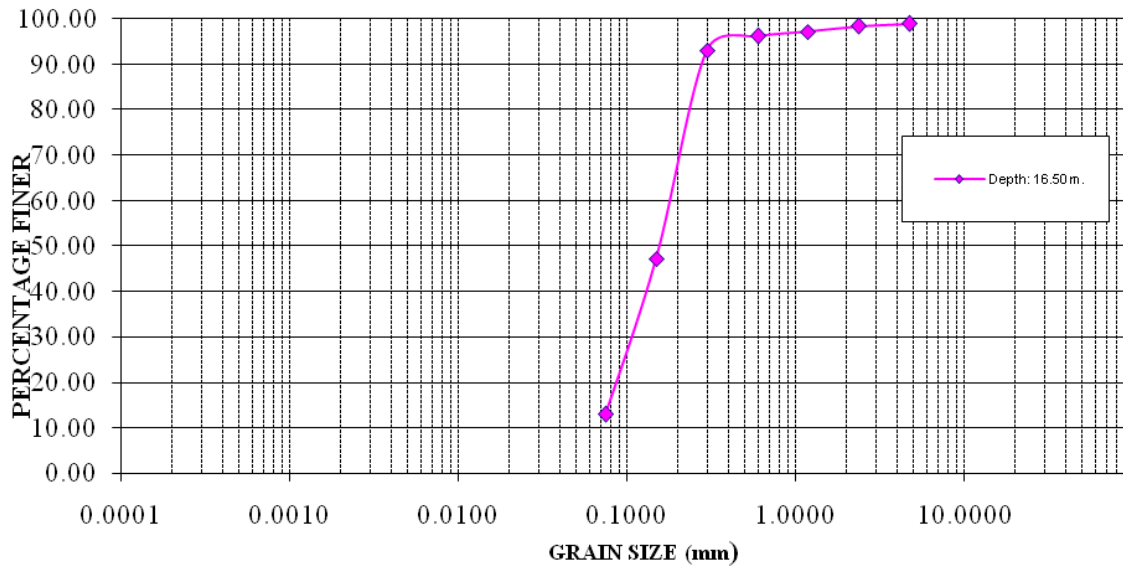
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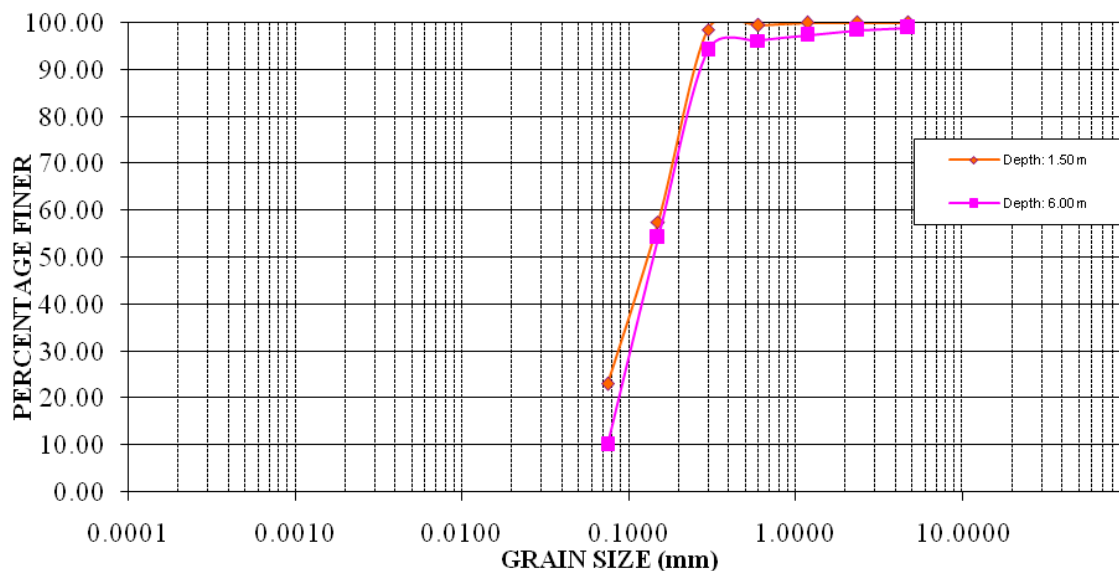


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v) BH – 6

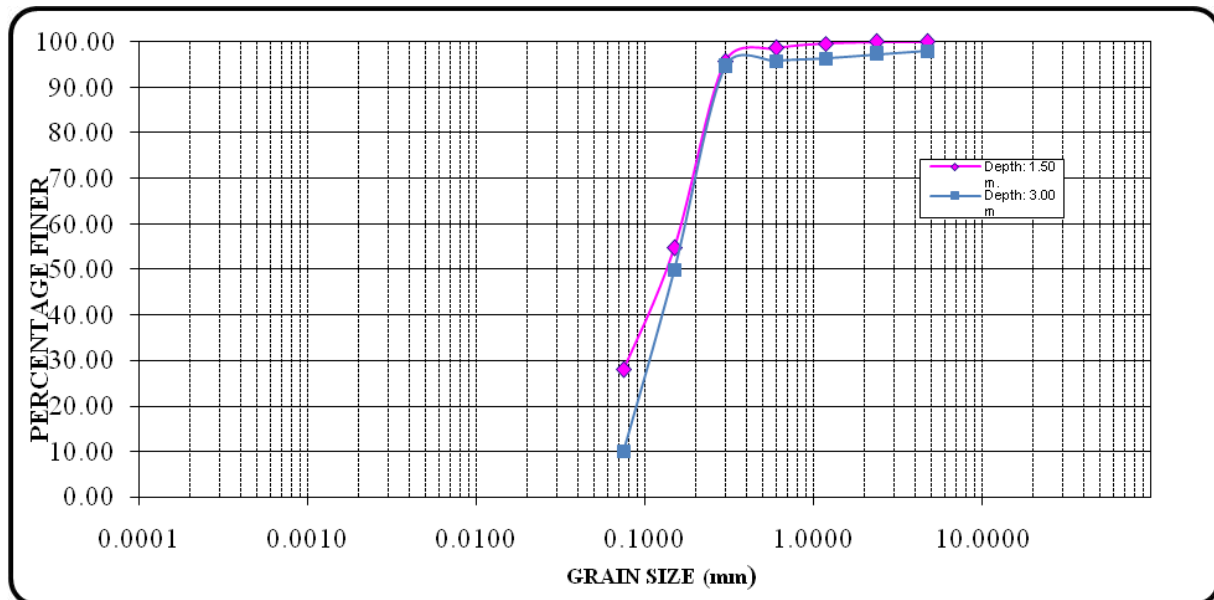




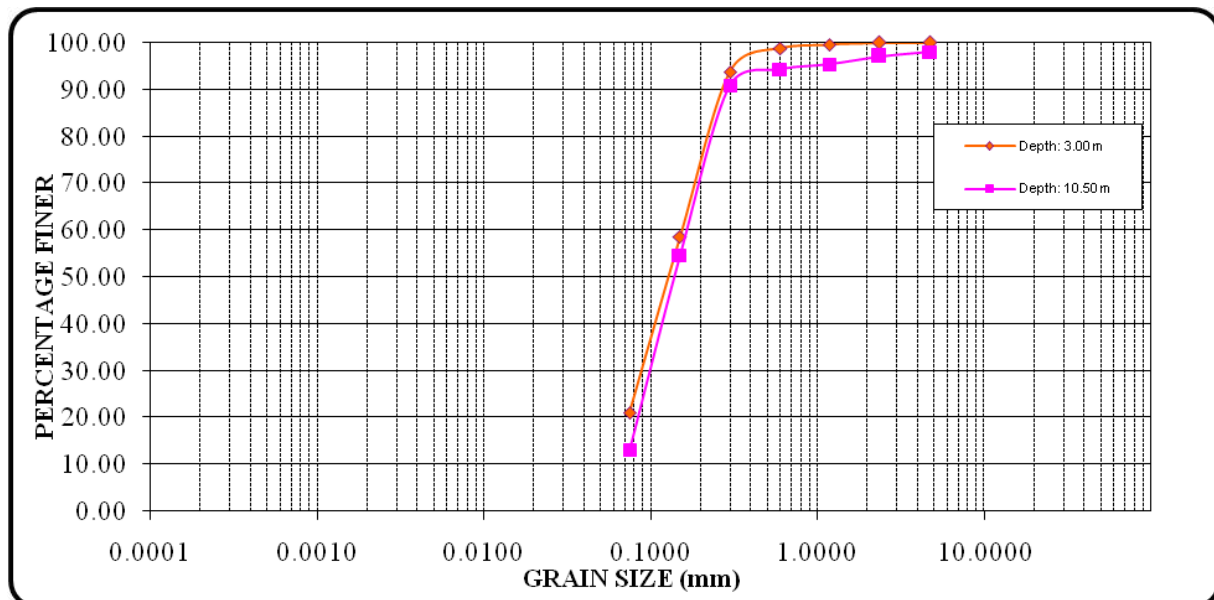
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vi) BH – 7



vii) BH – 8

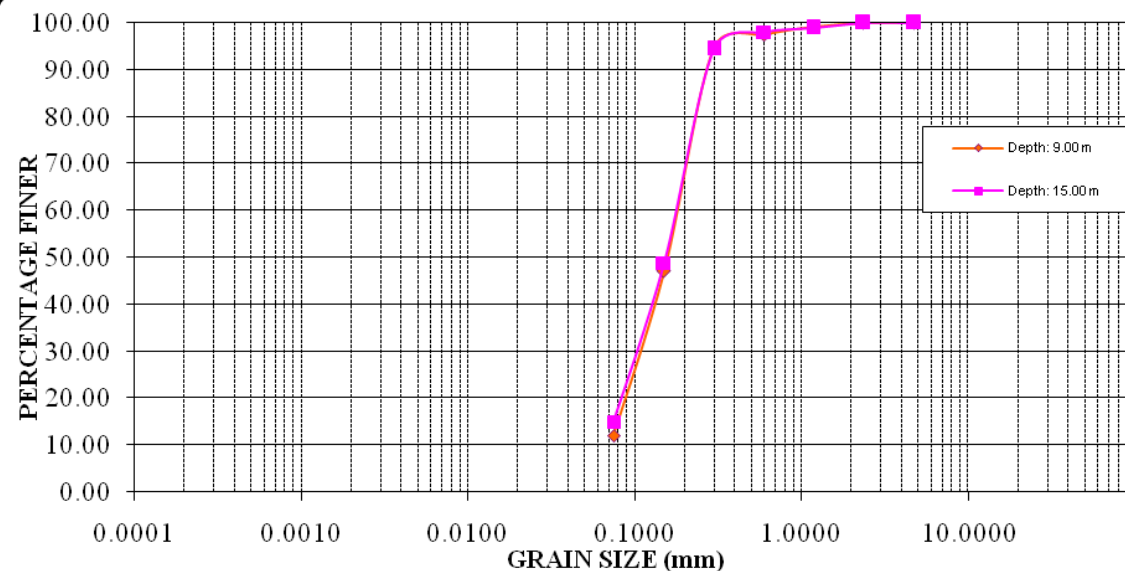
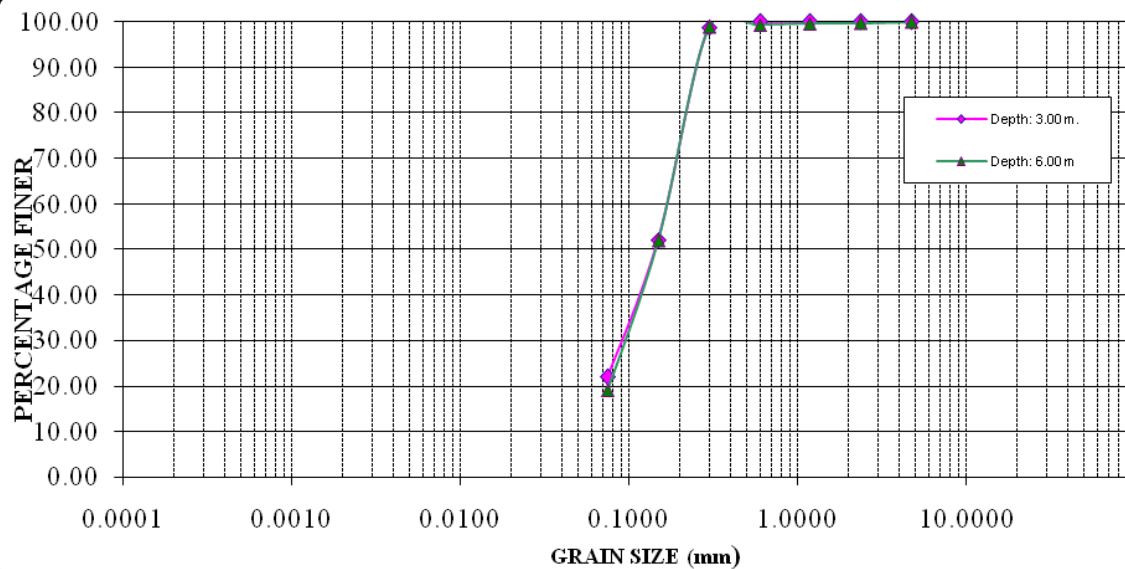




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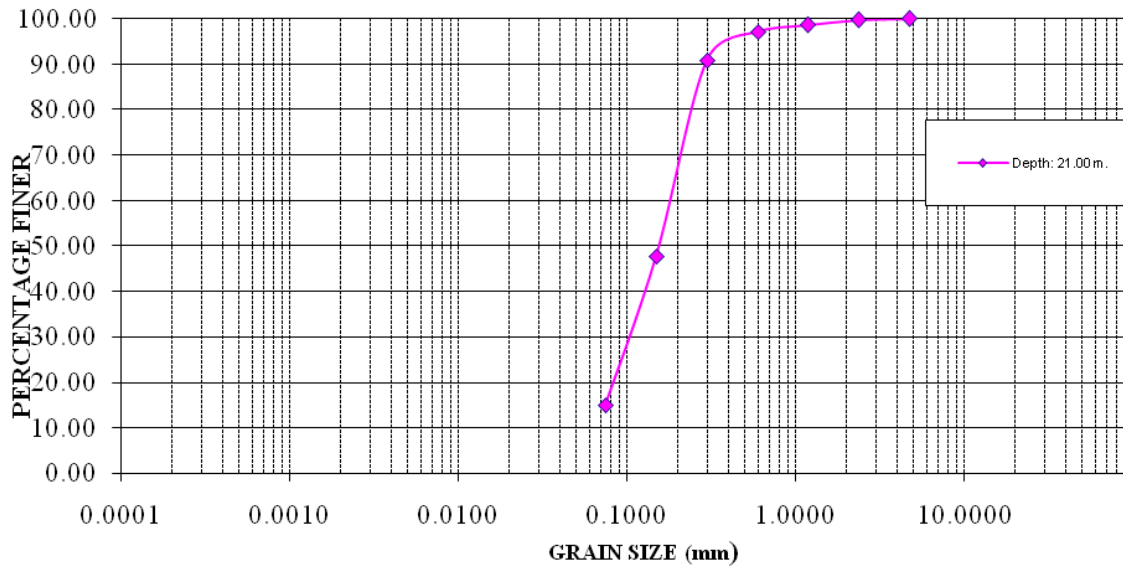
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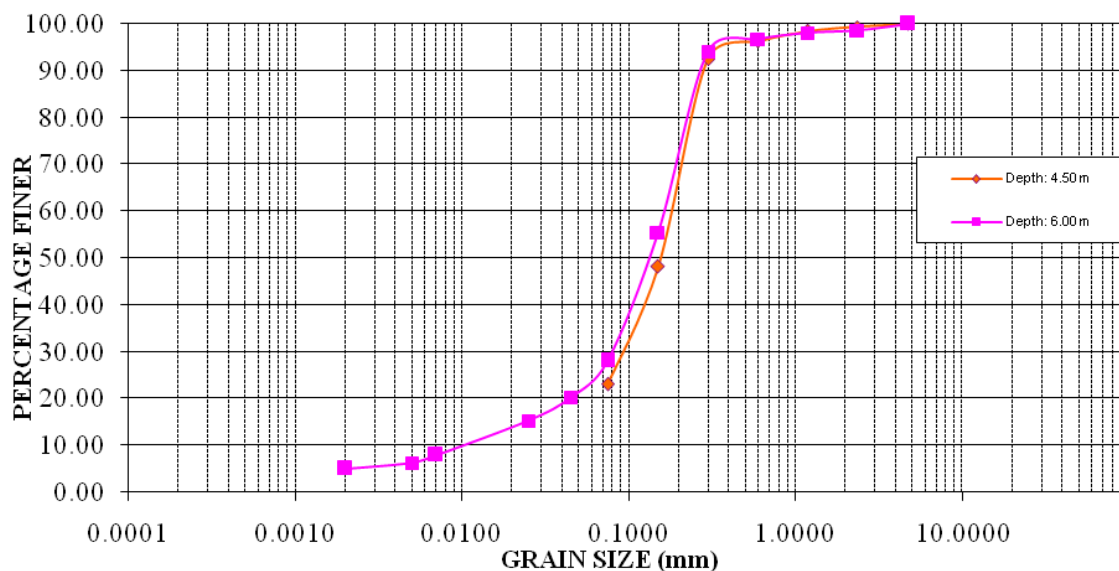


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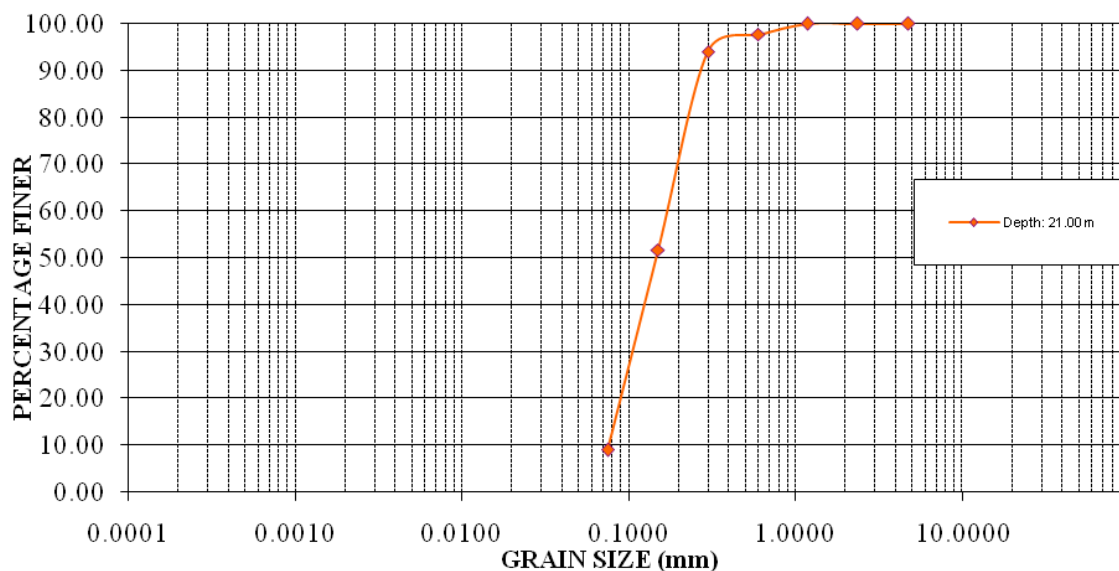
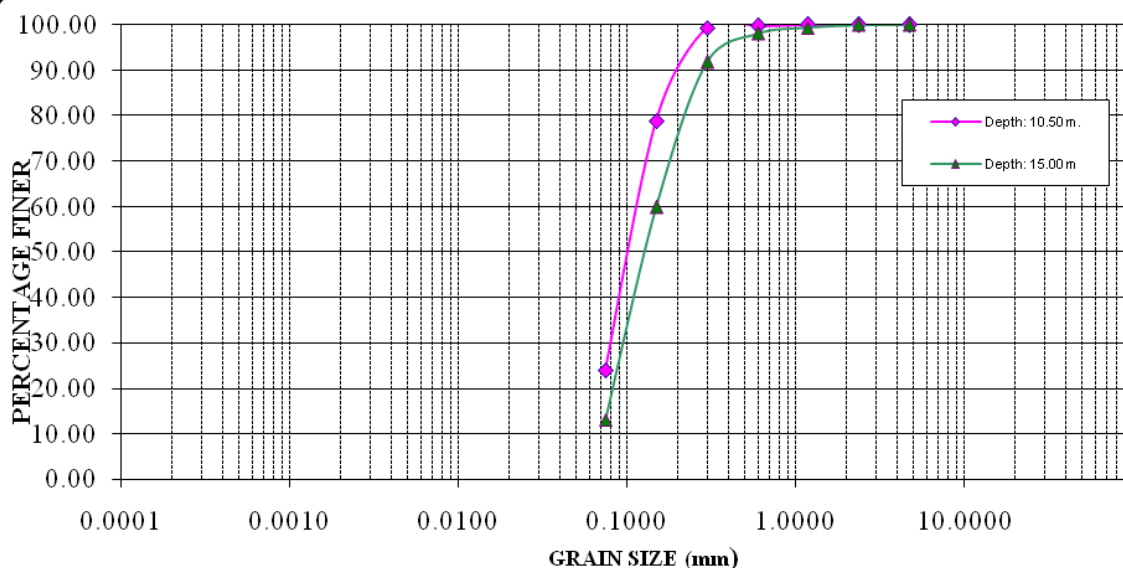
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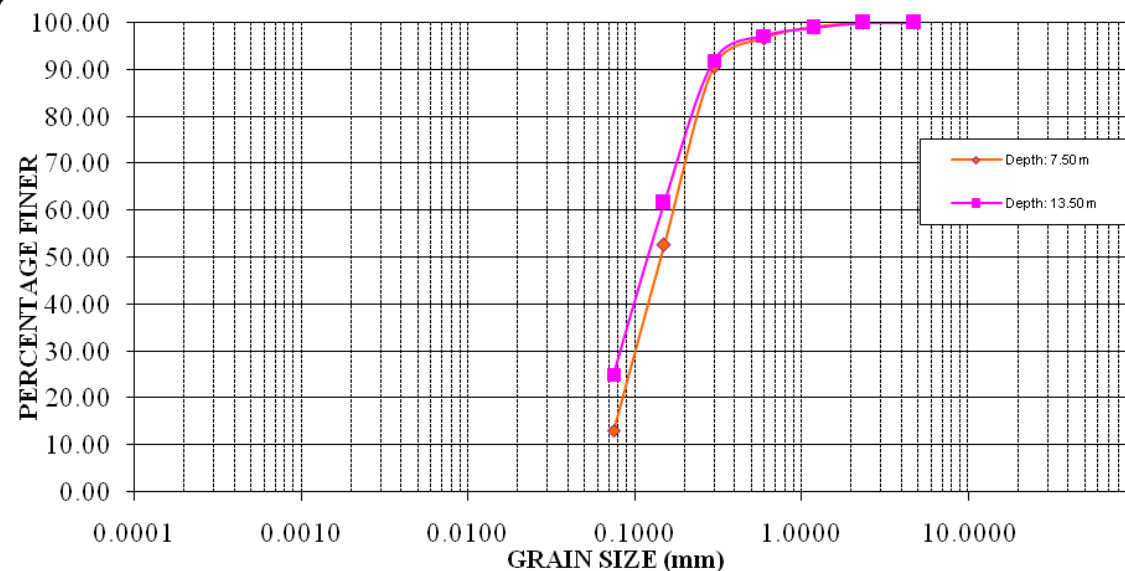
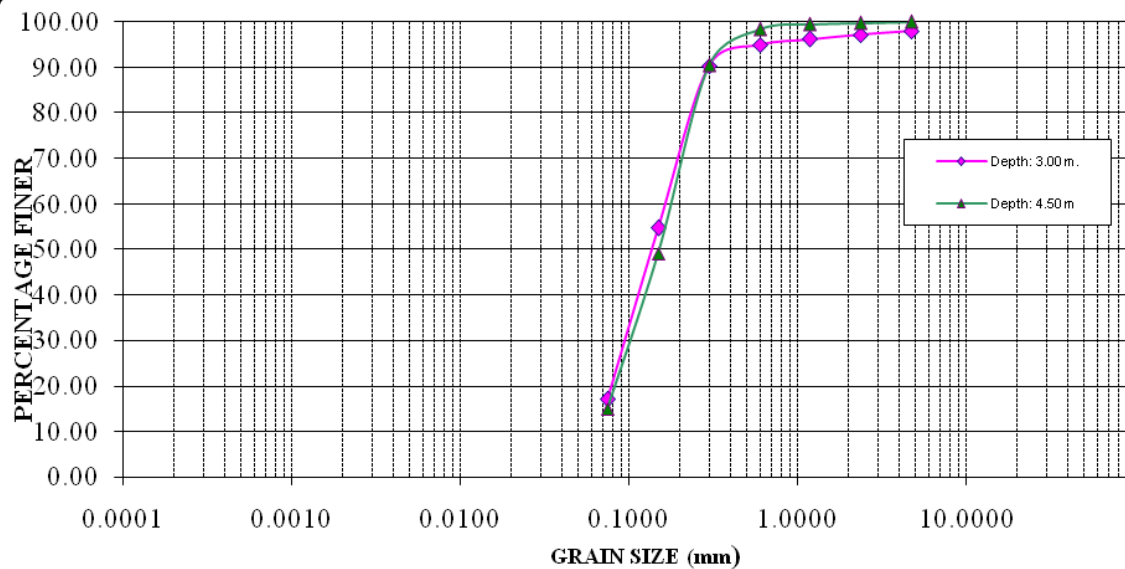




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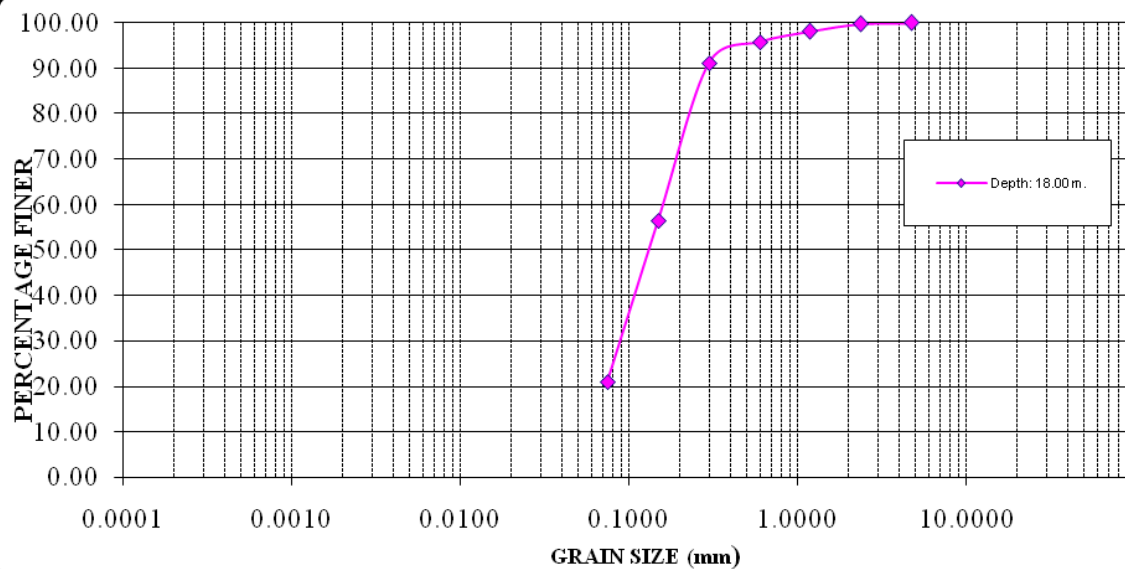
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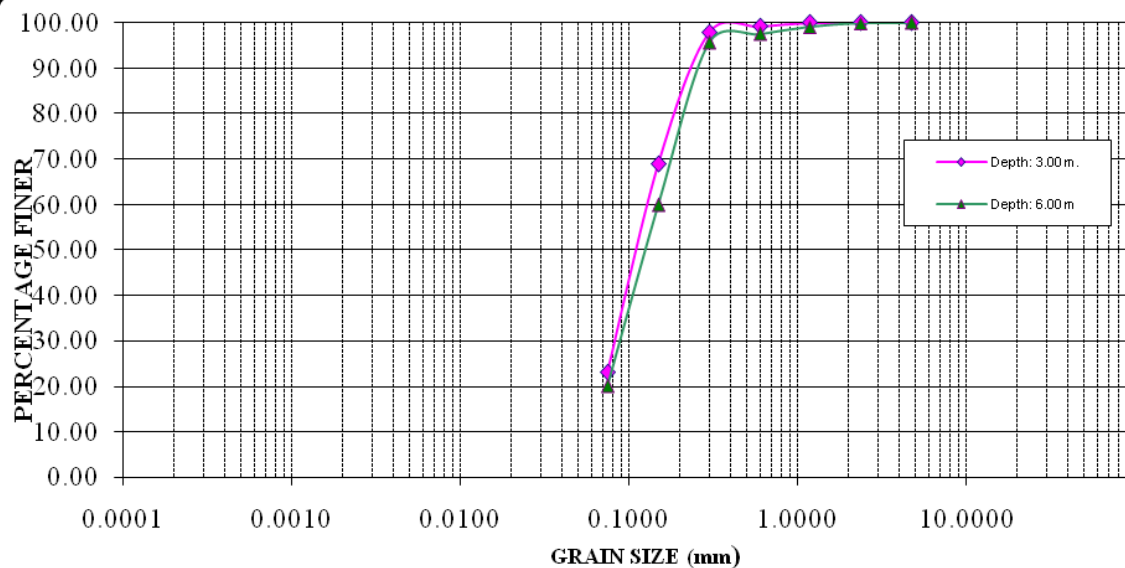


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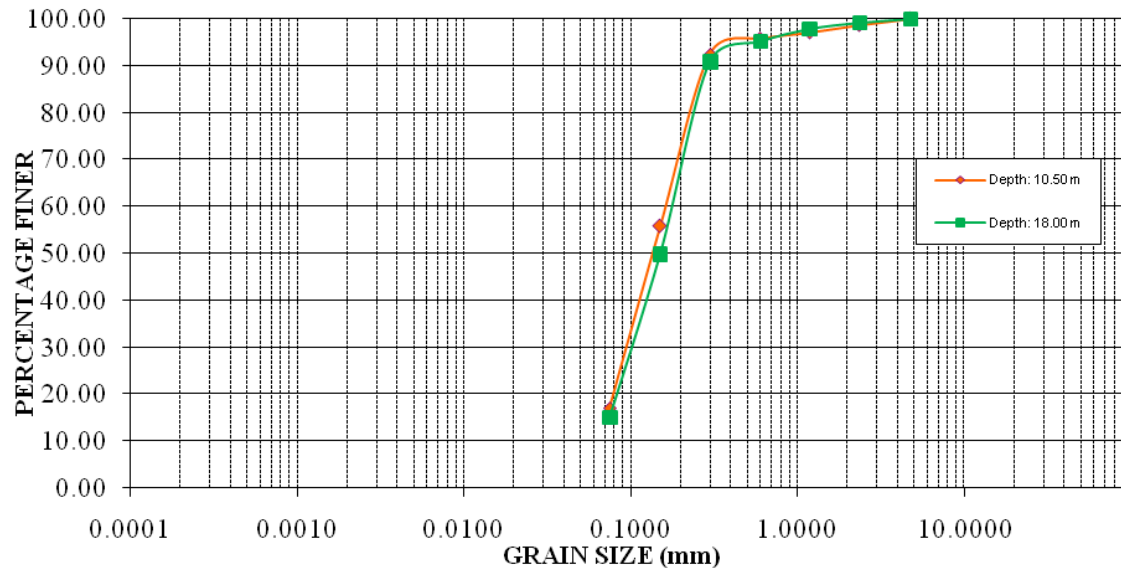
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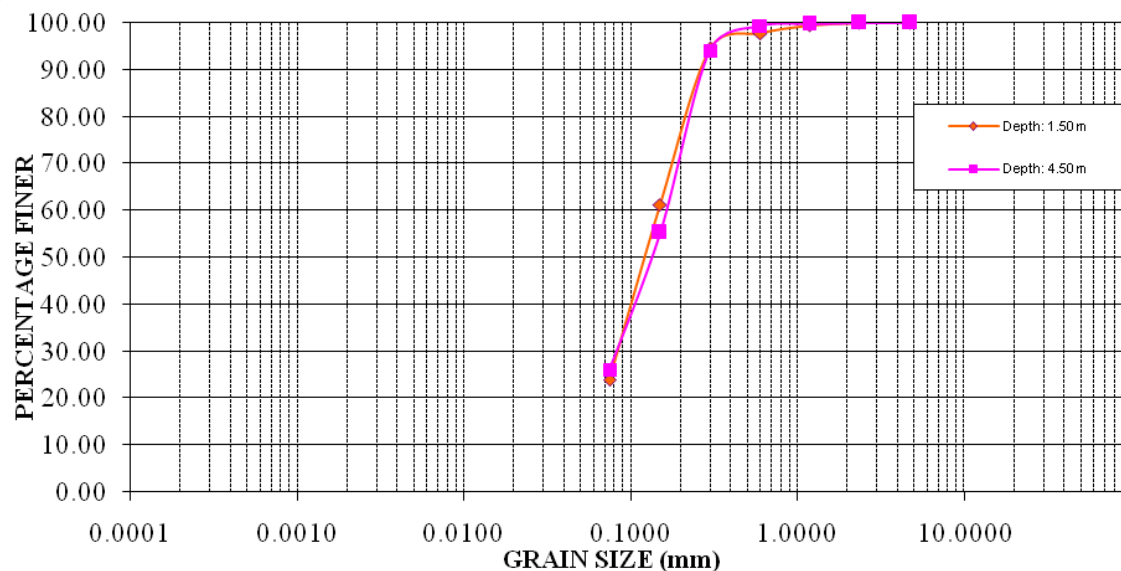


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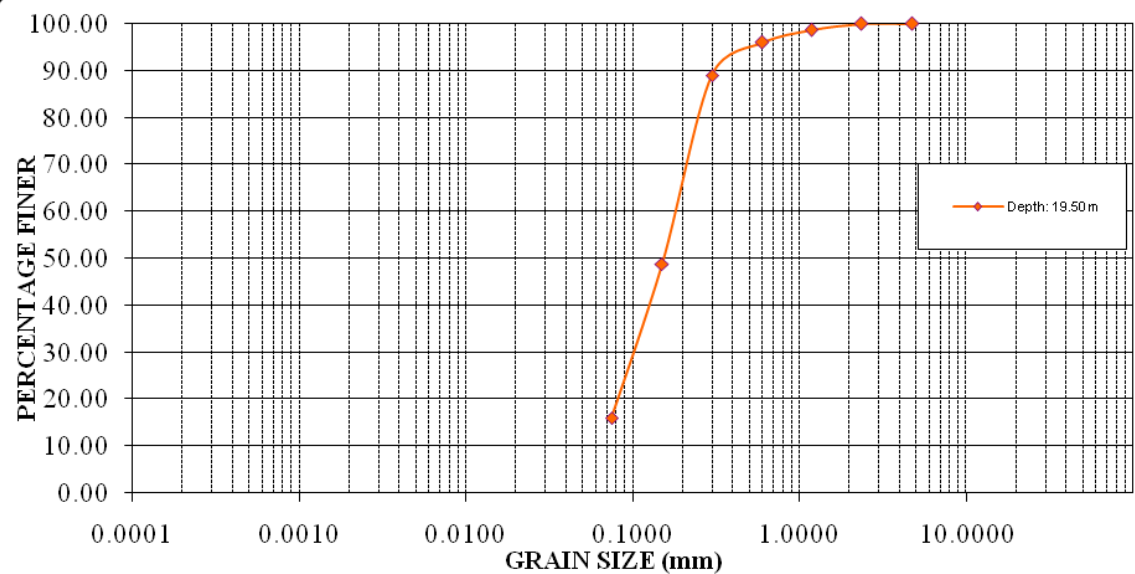
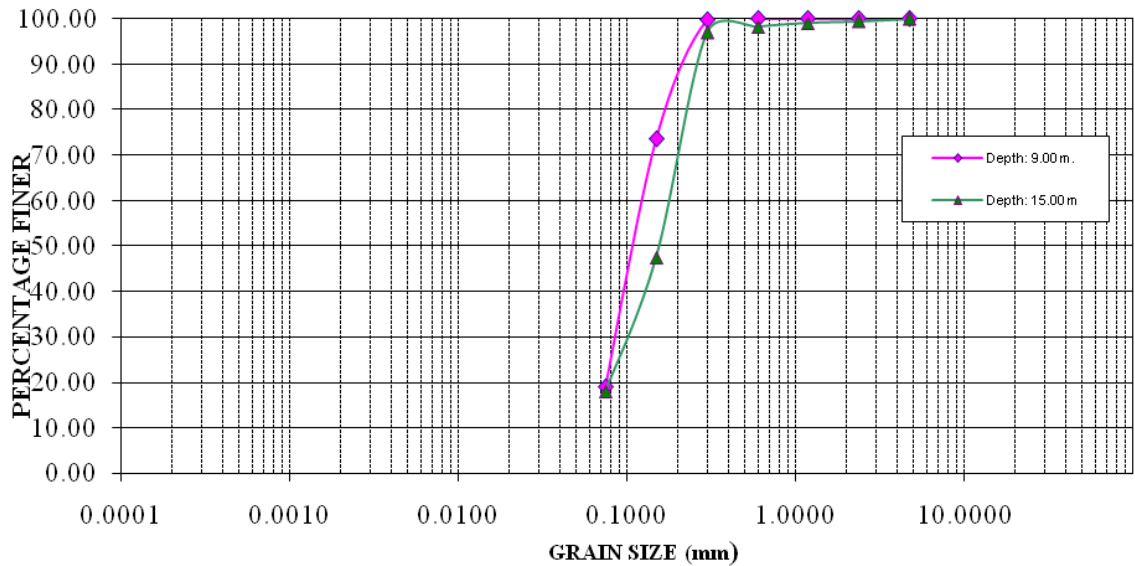
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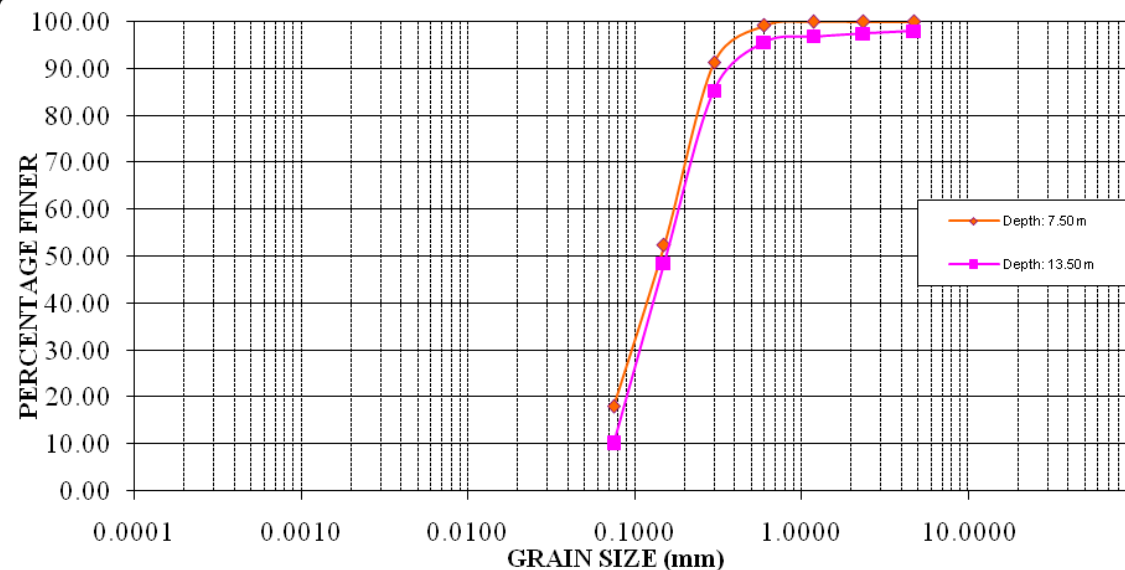
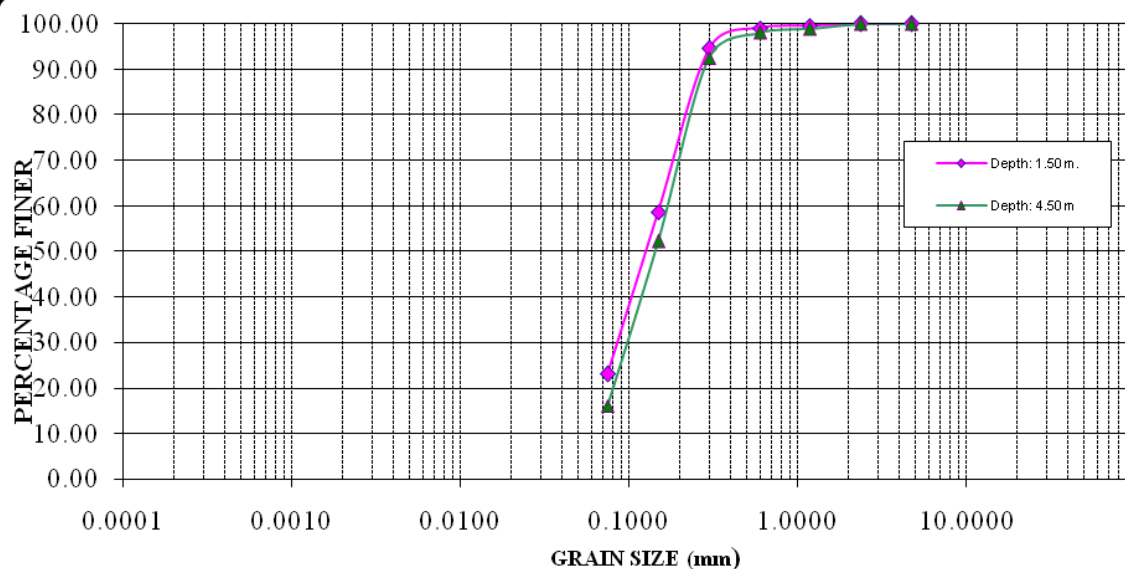




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xiii) BH – 14

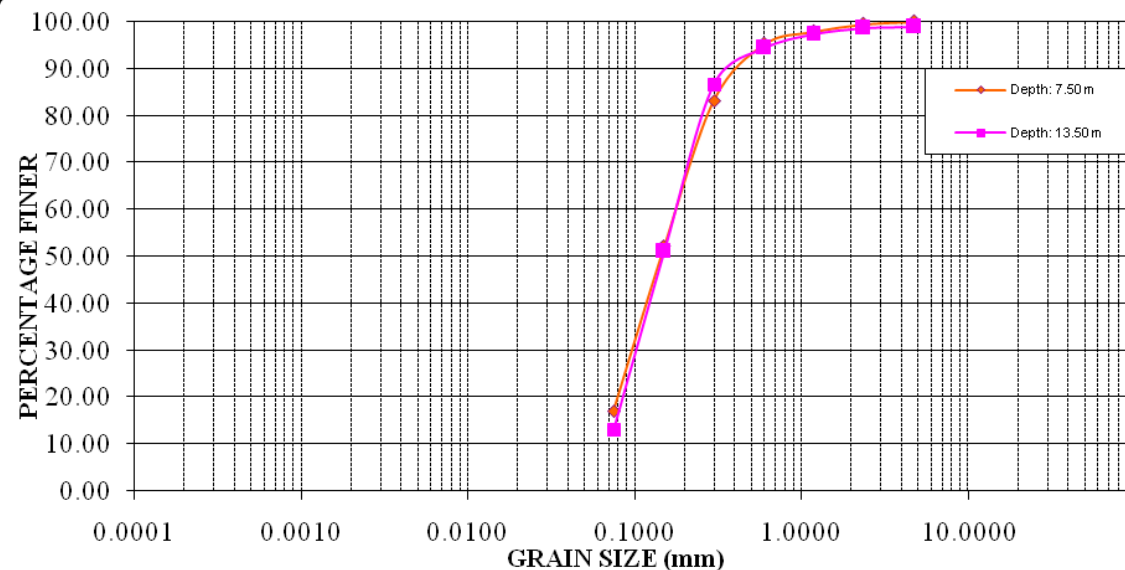
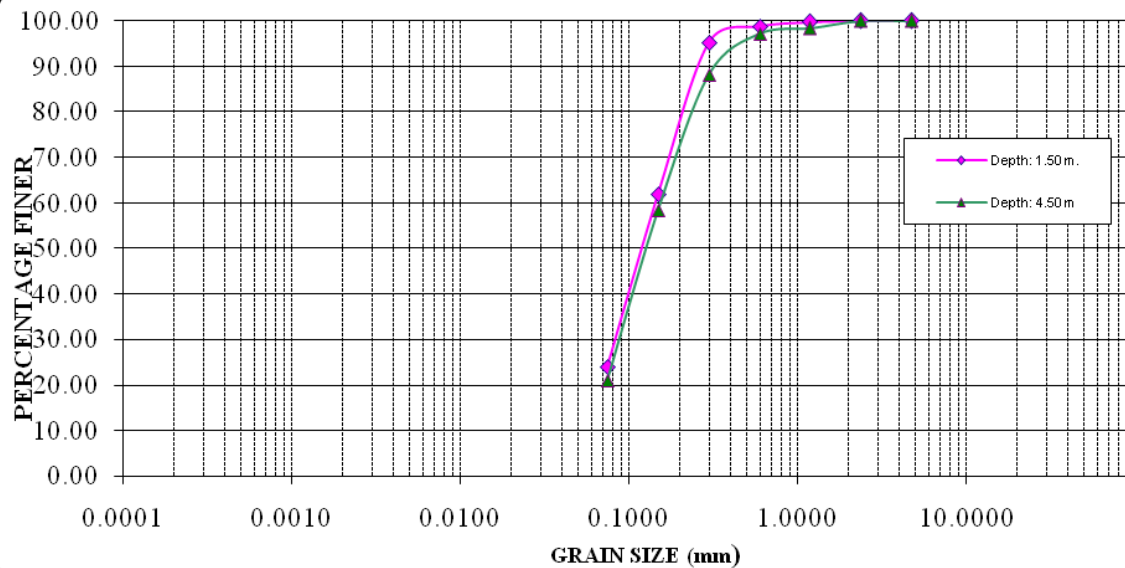




GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

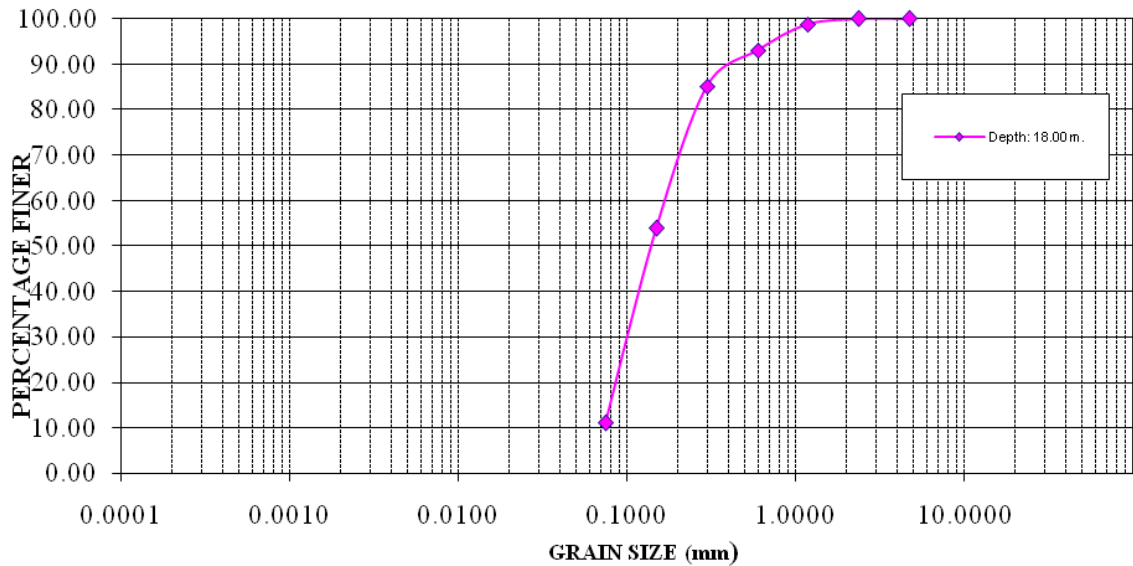
xiv) BH – 15



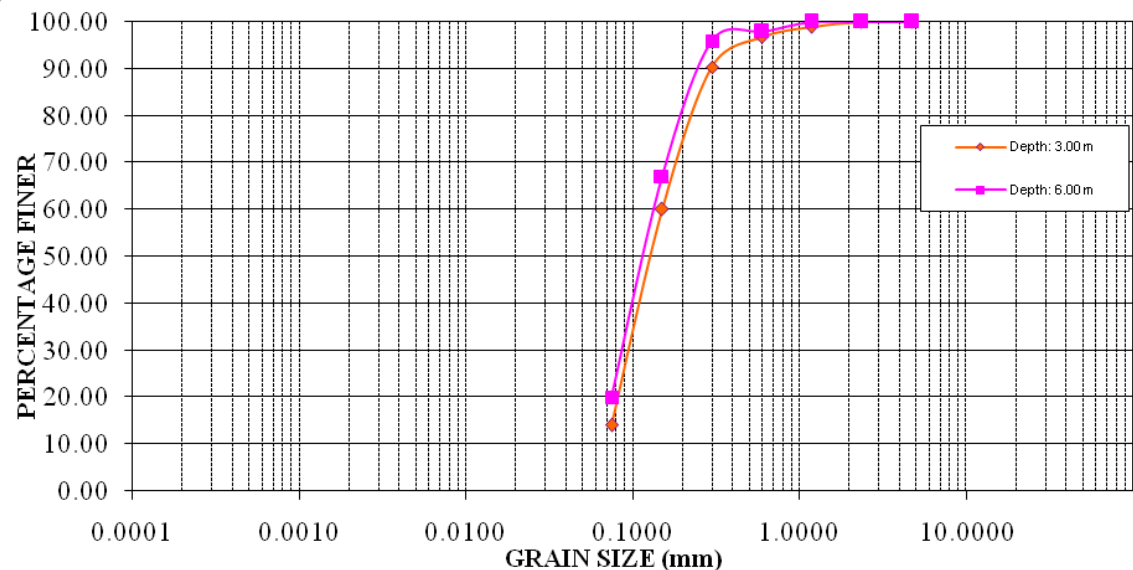


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025



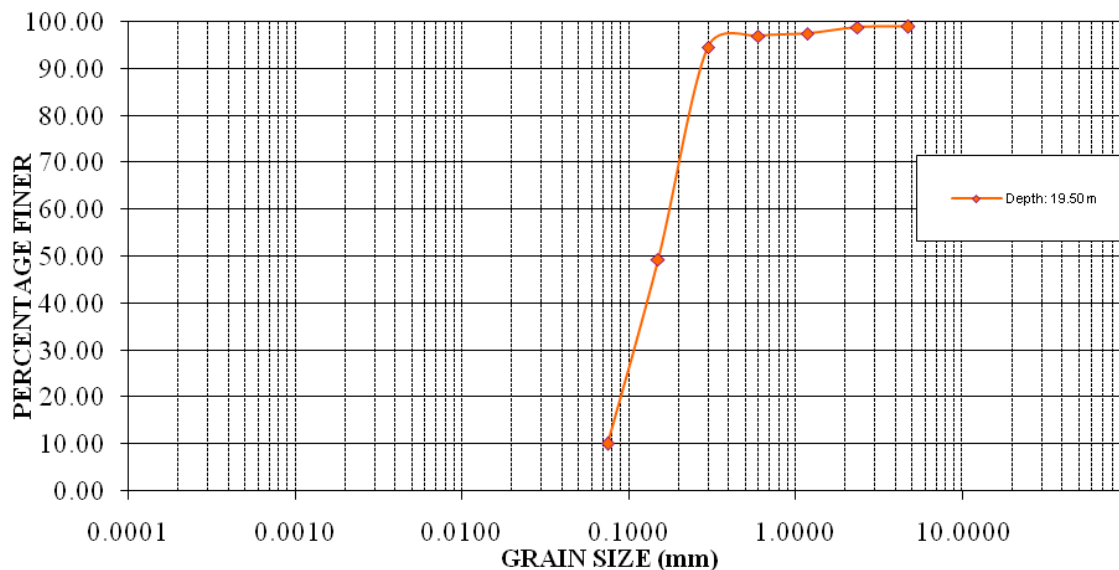
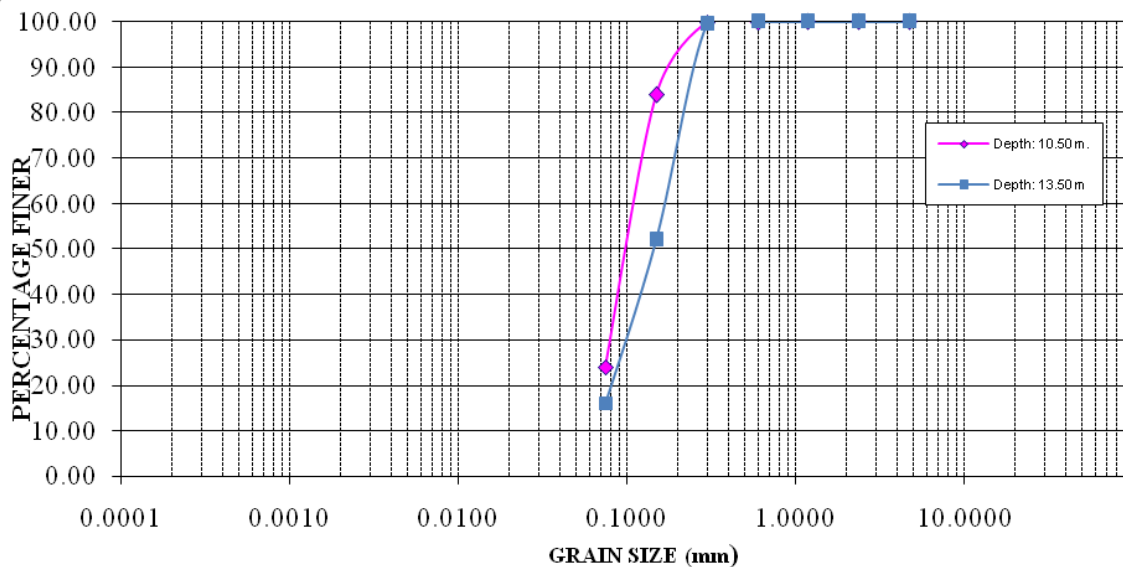
xv) BH – 16





GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

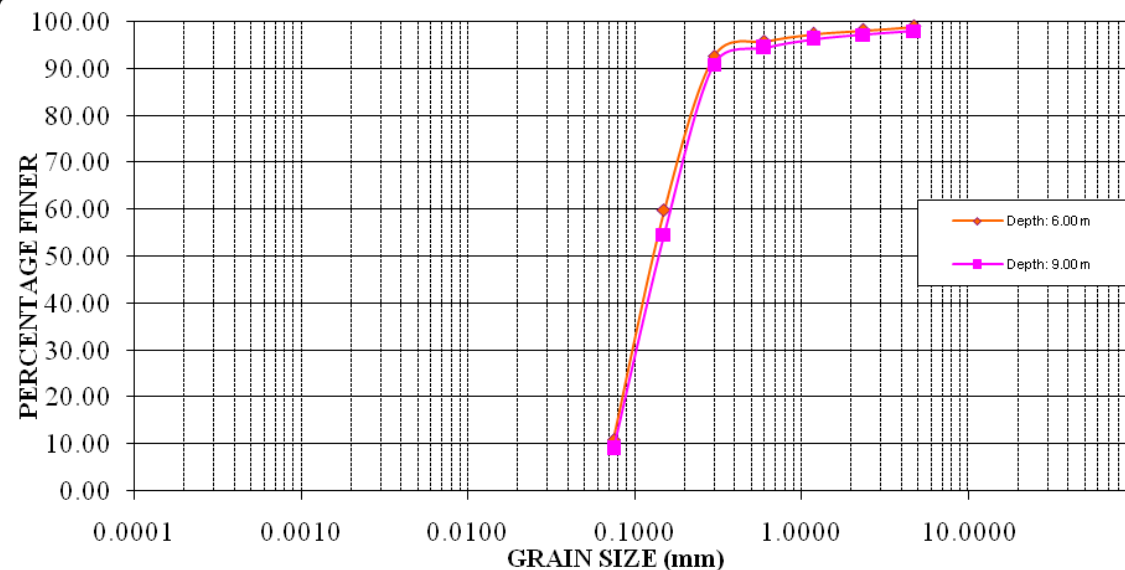
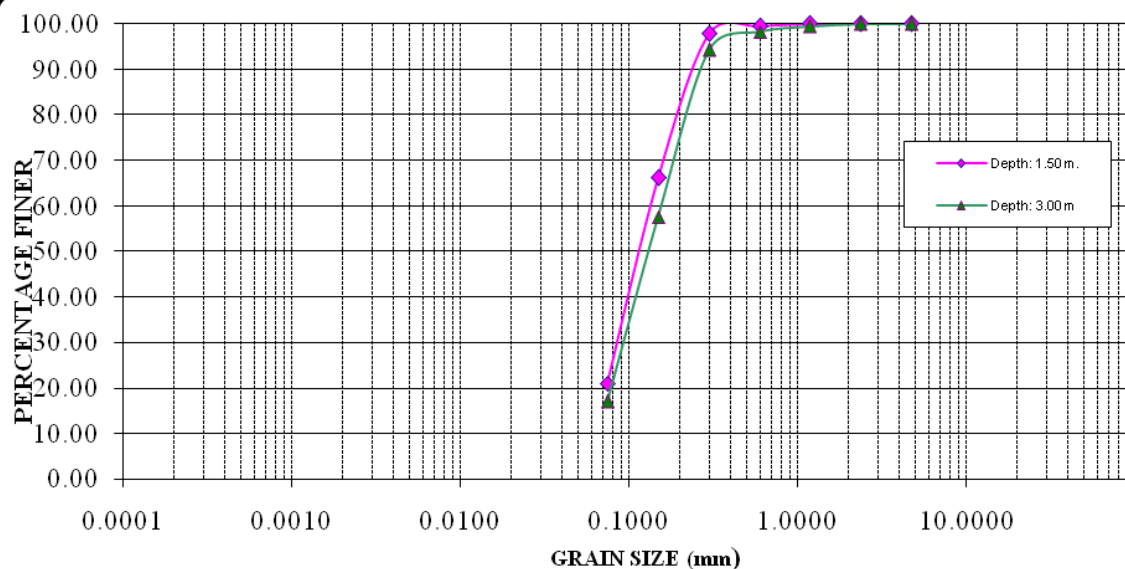




GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xvi) BH – 17

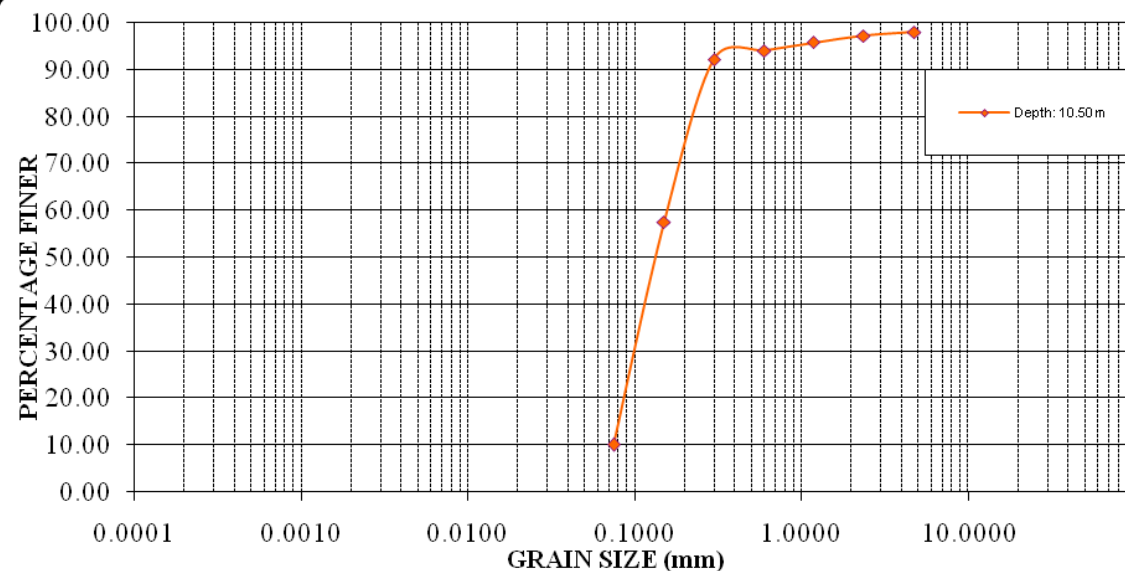
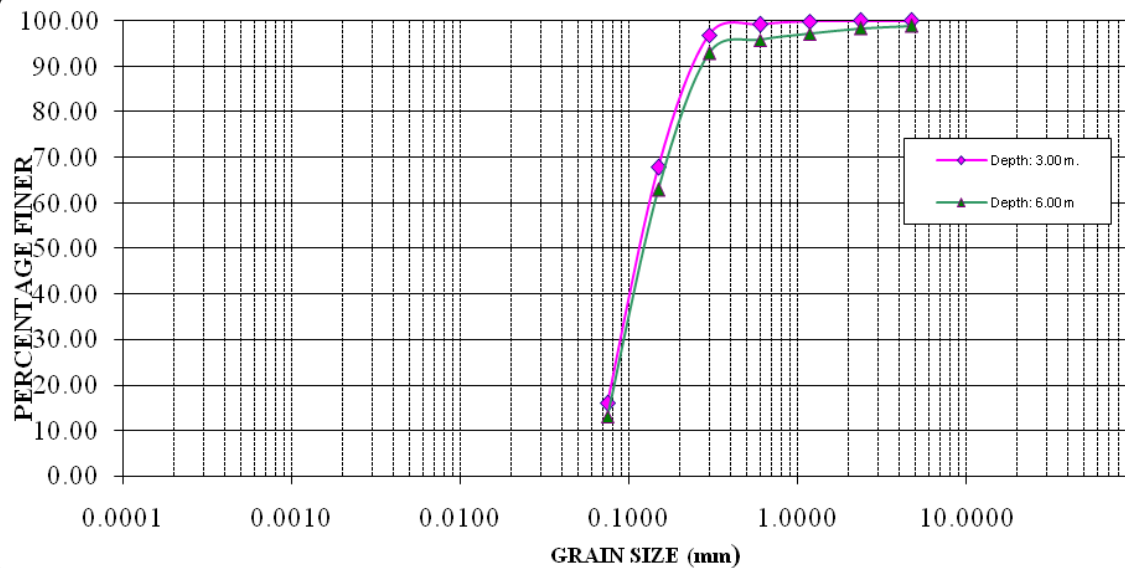




GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xvii) BH – 18

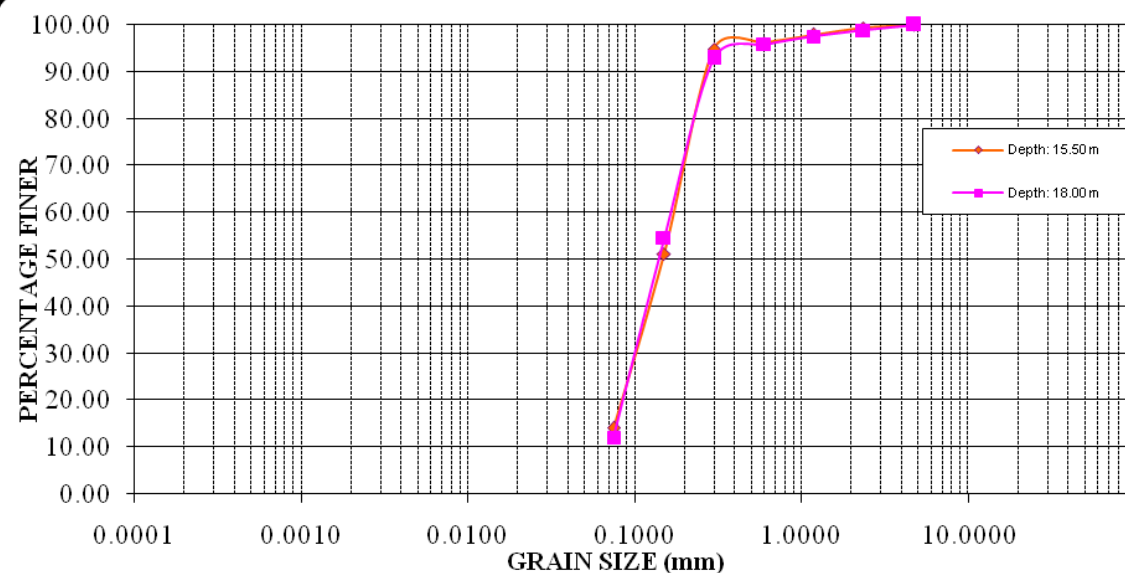
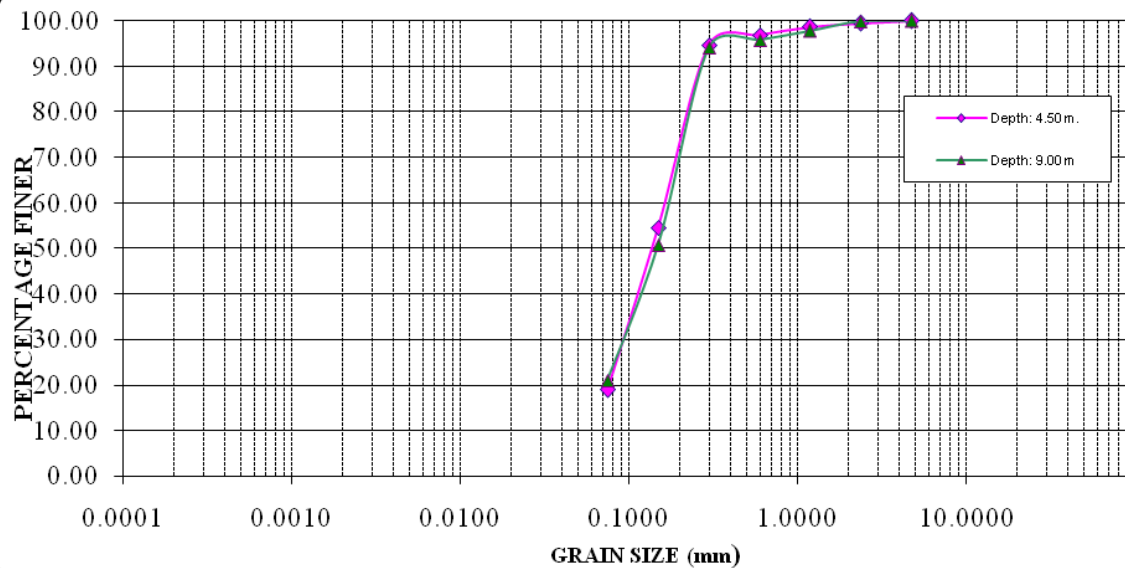




GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xviii) BH – 21

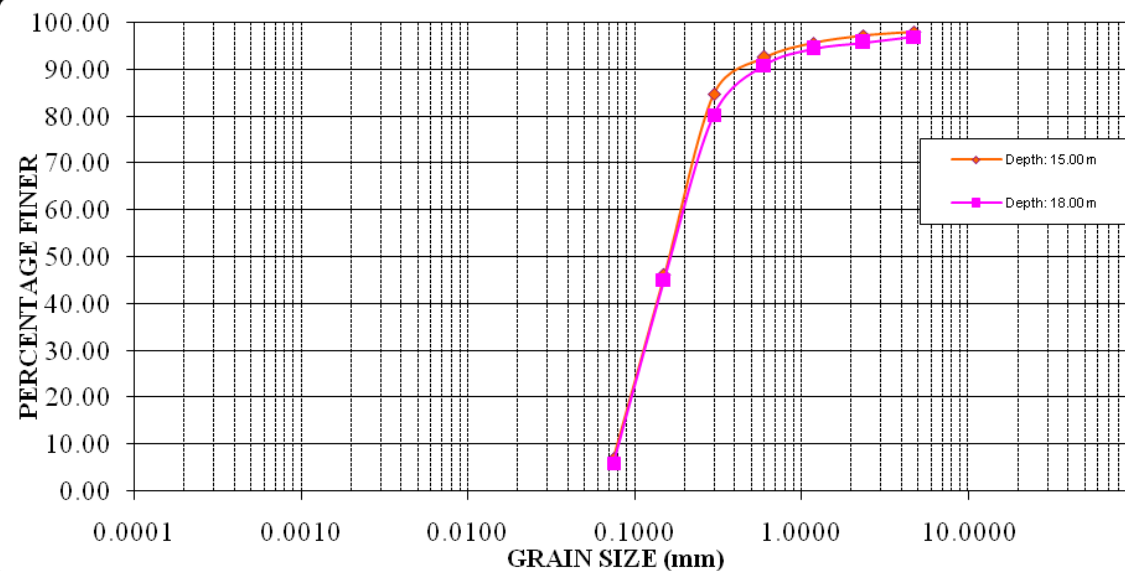
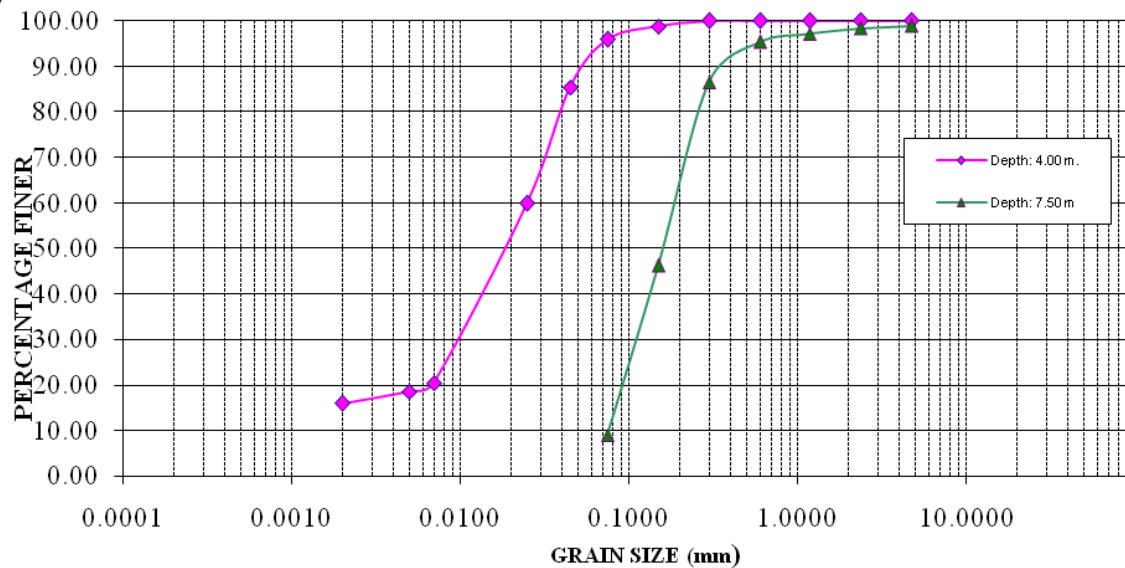




GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xix) BH – 22

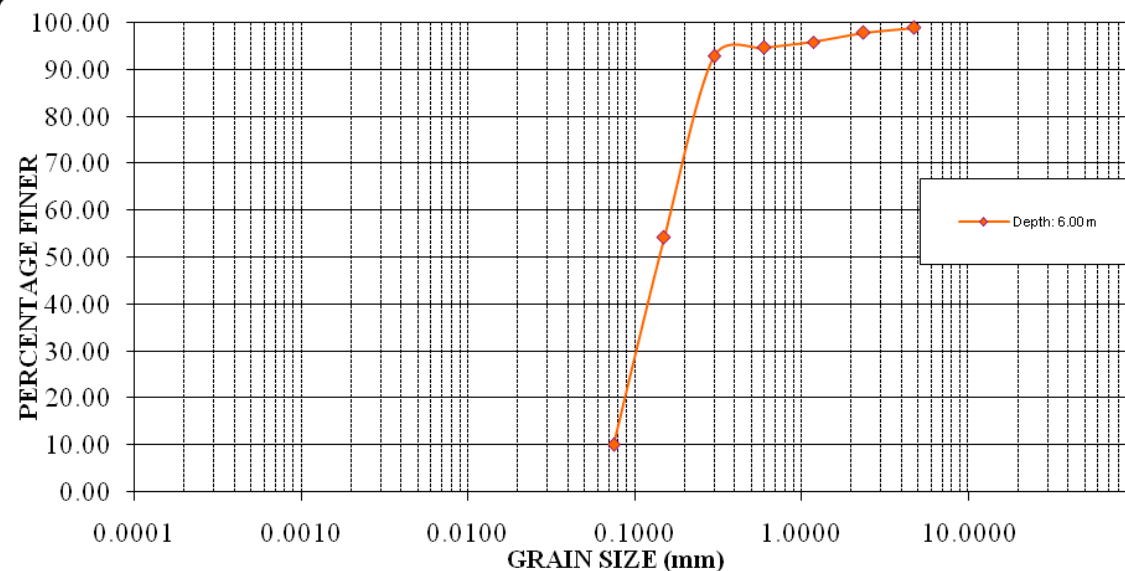
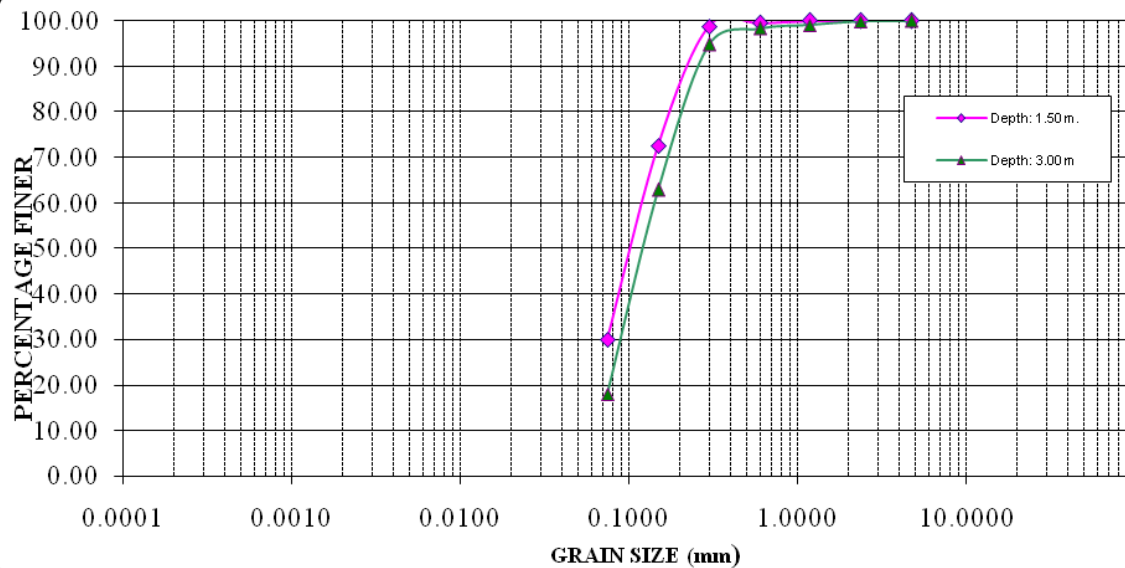




GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xx) BH – 23

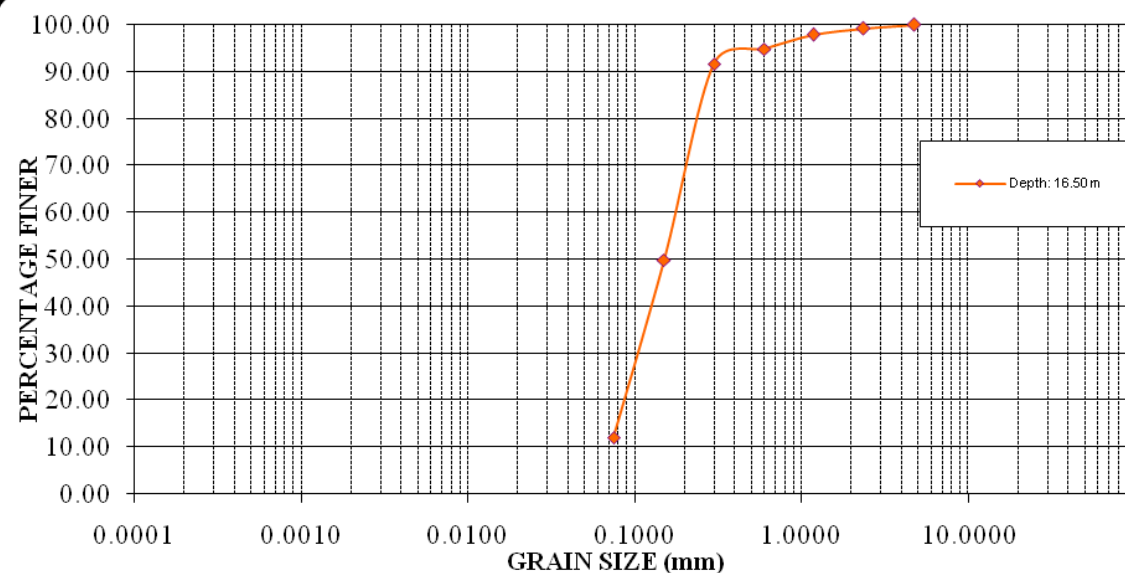
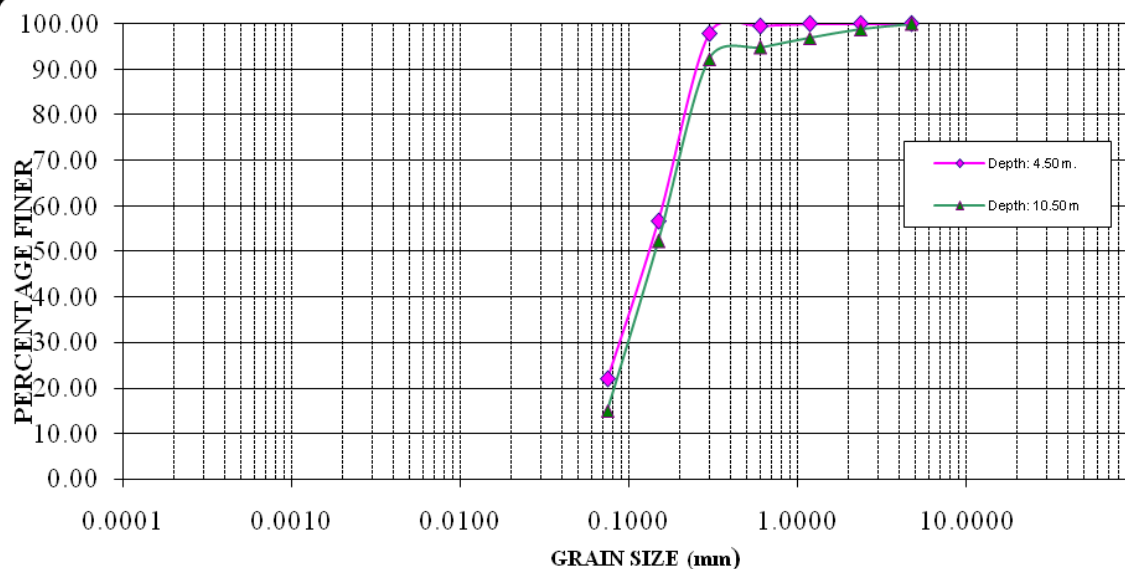




GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xxi) BH – 24

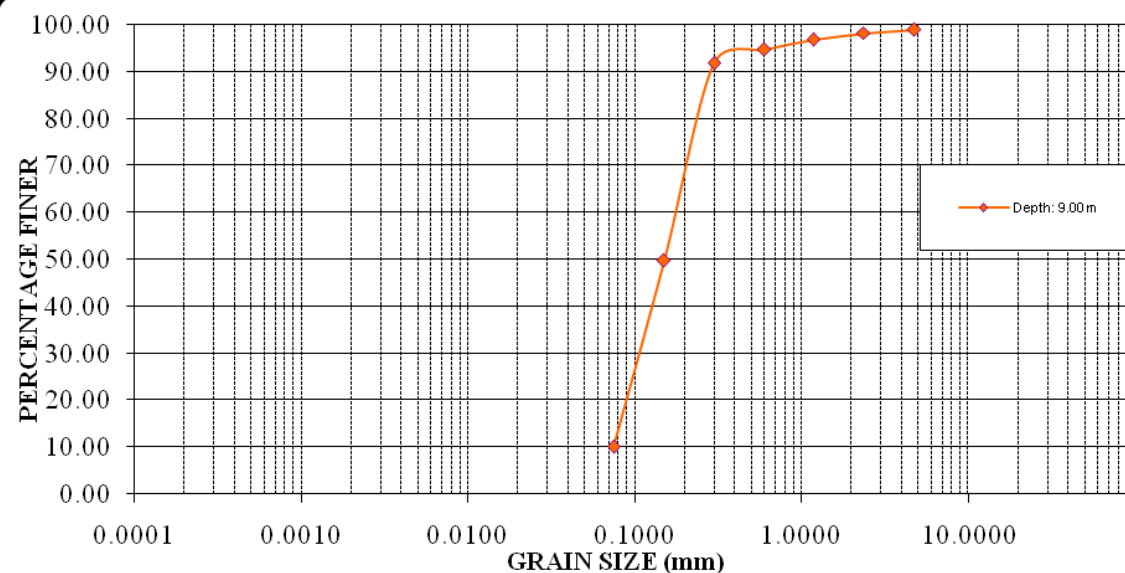
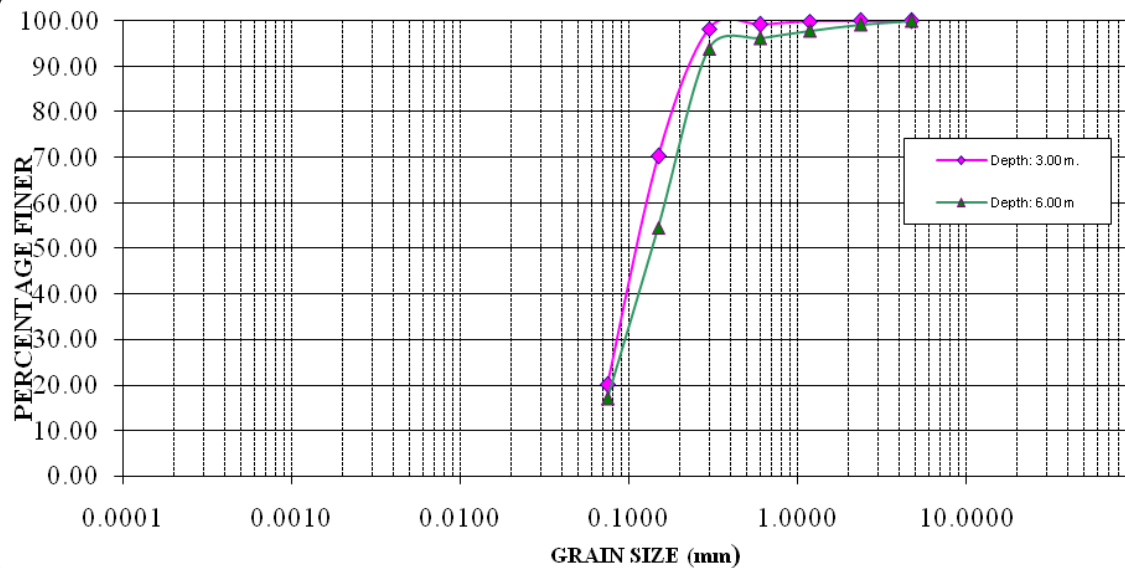




GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

xxii) BH – 25





GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

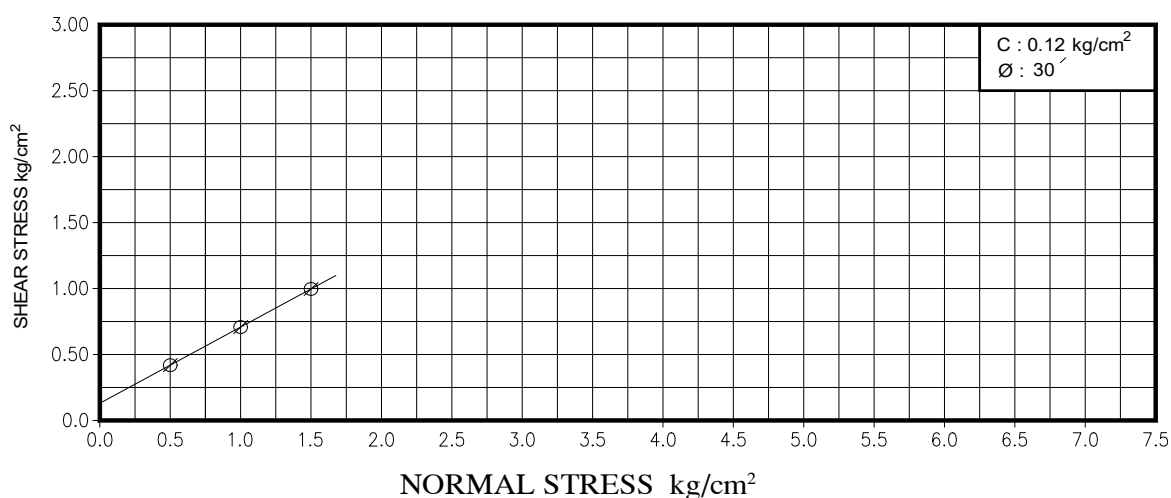
PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

Annexure – XIV Shear Test Curves

DIRECT SHEAR TEST CURVE (DS)

BH NO. 1

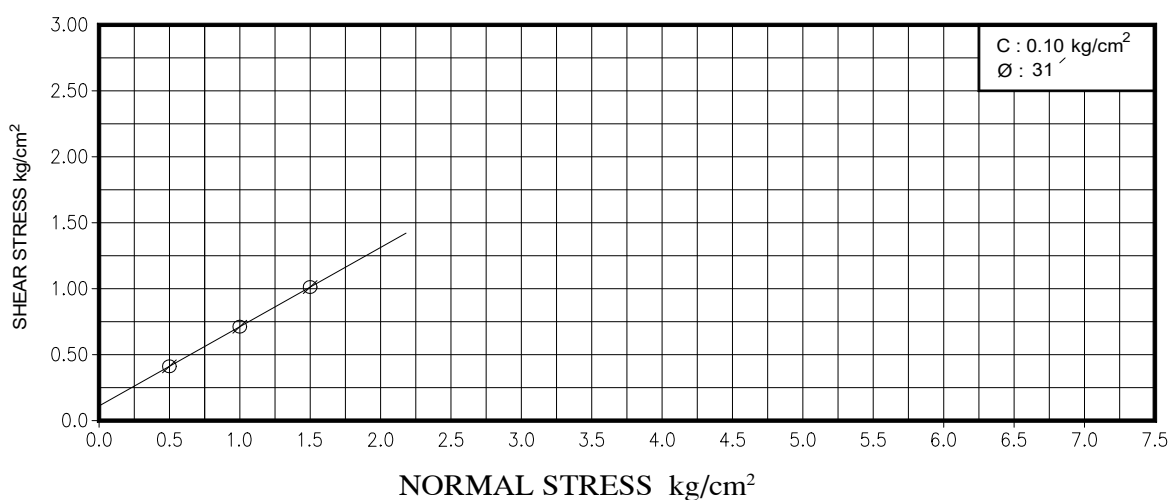
Depth (m):- 3.00



DIRECT SHEAR TEST CURVE (DS)

BH NO. 3

Depth (m):- 1.50





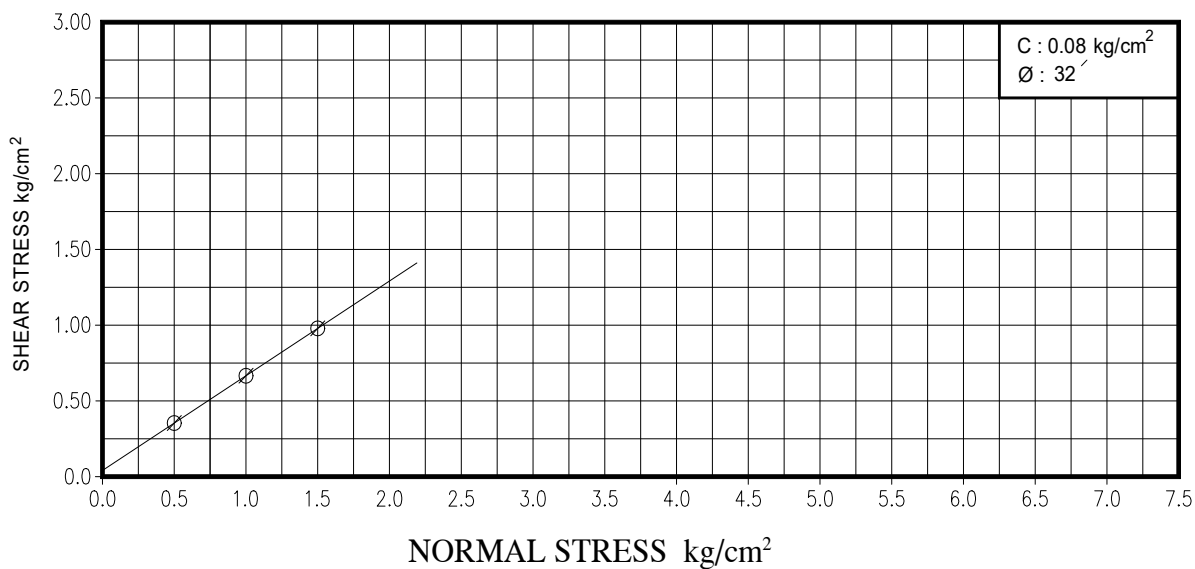
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 4

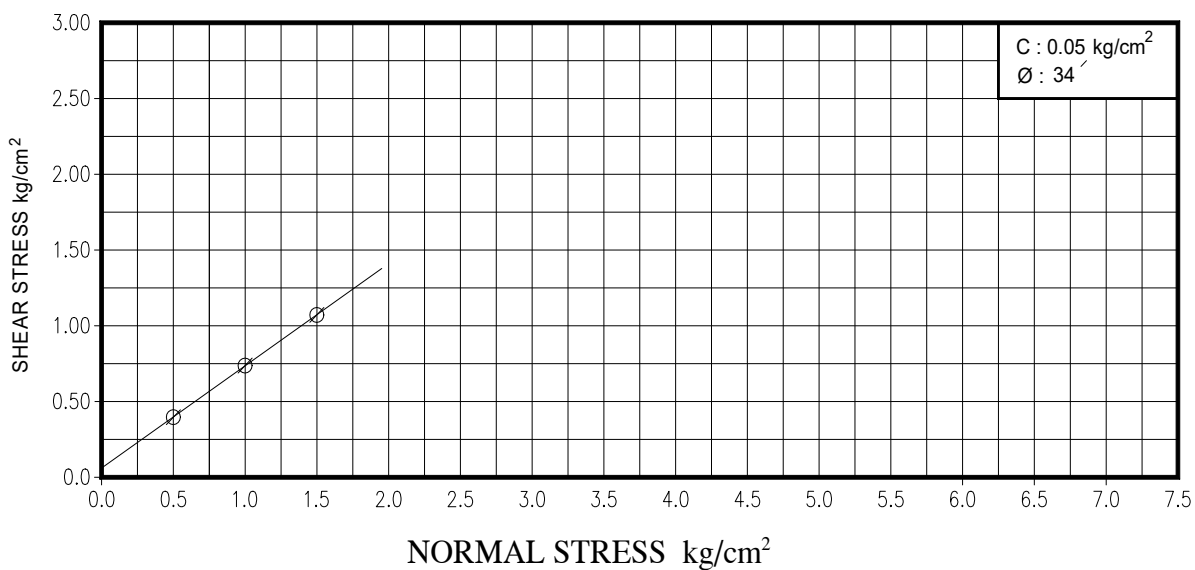
Depth (m):- 1.00



DIRECT SHEAR TEST CURVE (DS)

BH NO. 4

Depth (m):- 9.00





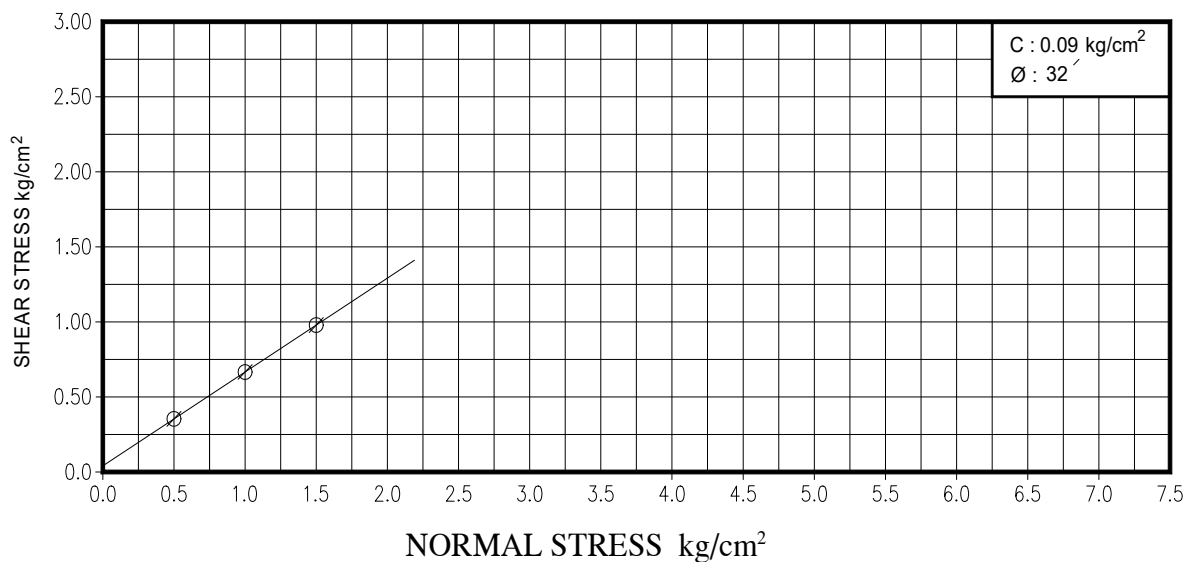
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 5

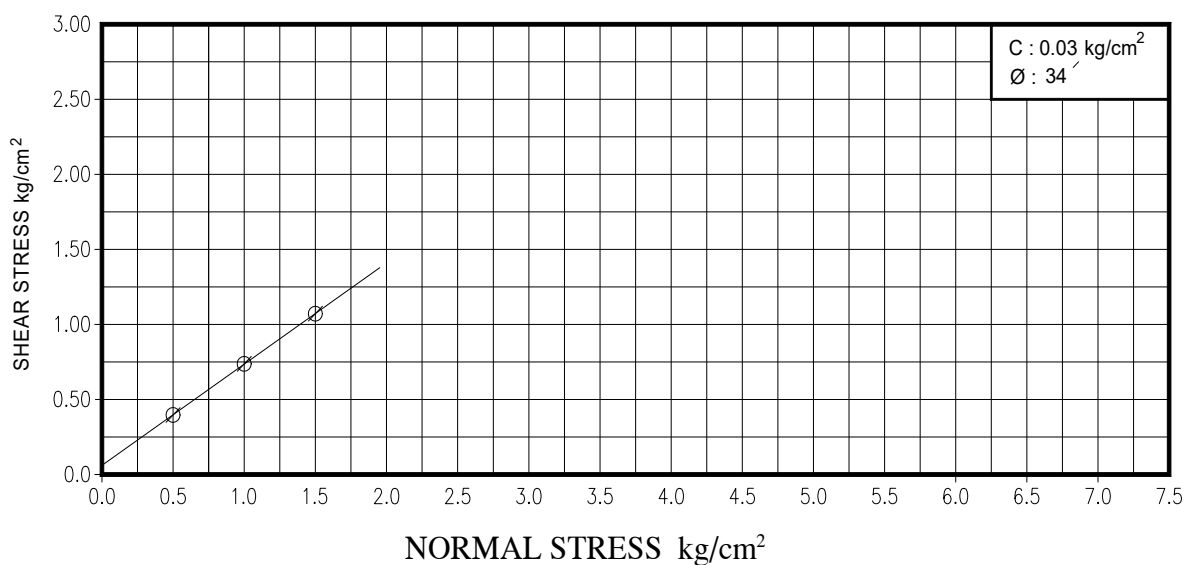
Depth (m):- 4.50



DIRECT SHEAR TEST CURVE (DS)

BH NO. 5

Depth (m):- 13.50





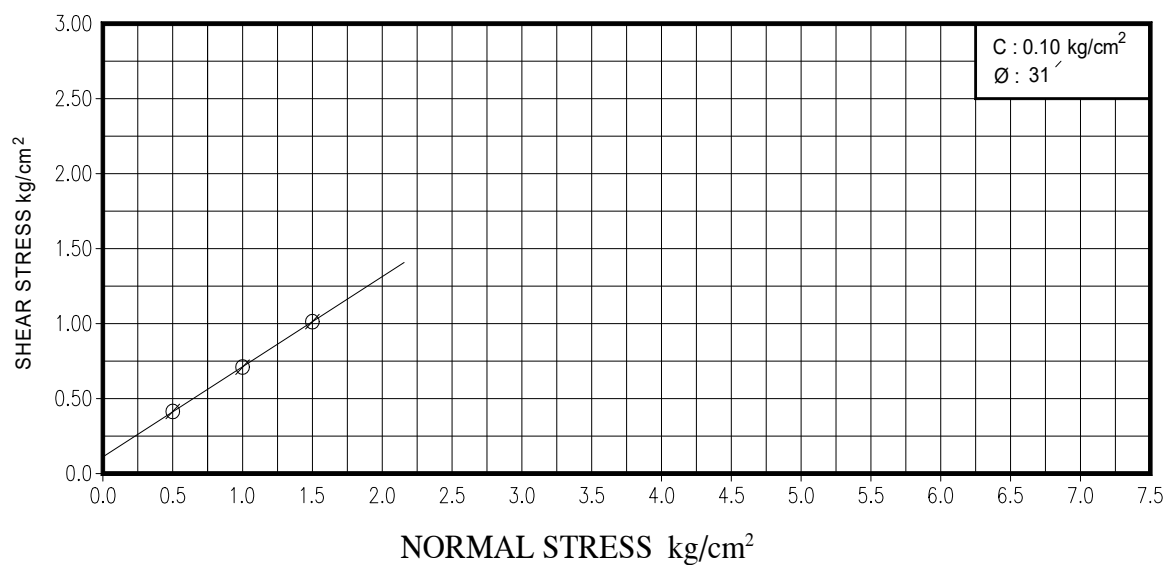
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 6

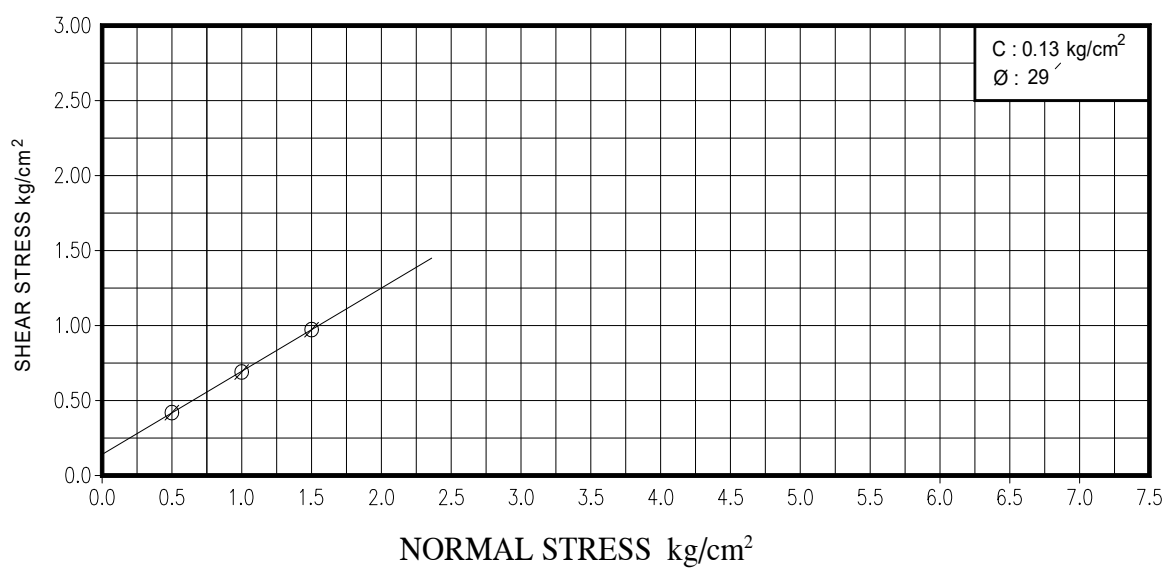
Depth (m):- 1.50



DIRECT SHEAR TEST CURVE (DS)

BH NO. 7

Depth (m):- 1.50





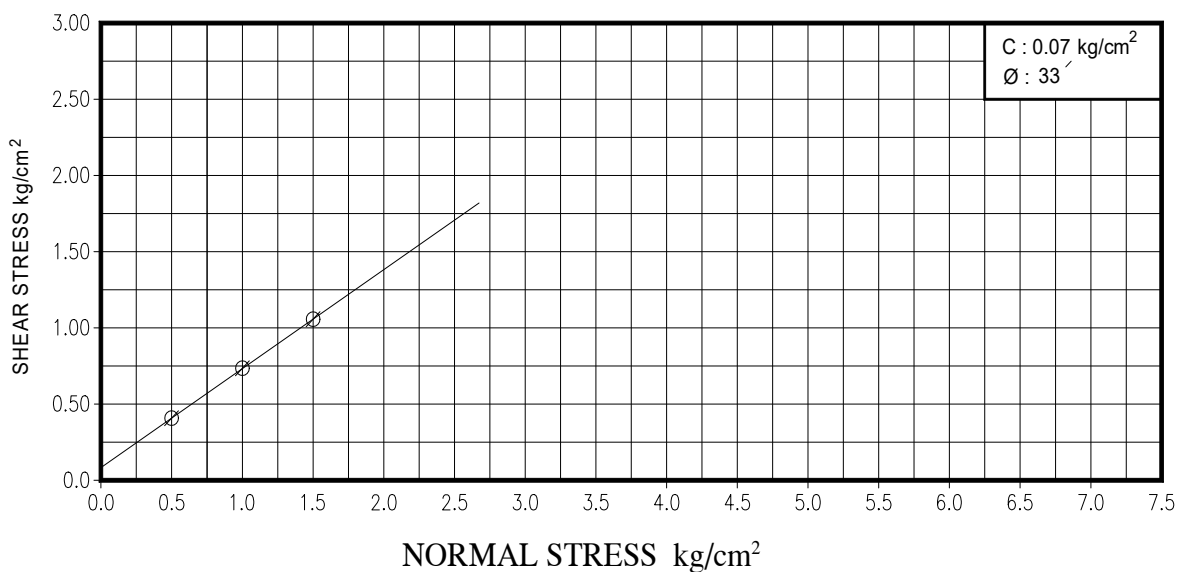
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 8

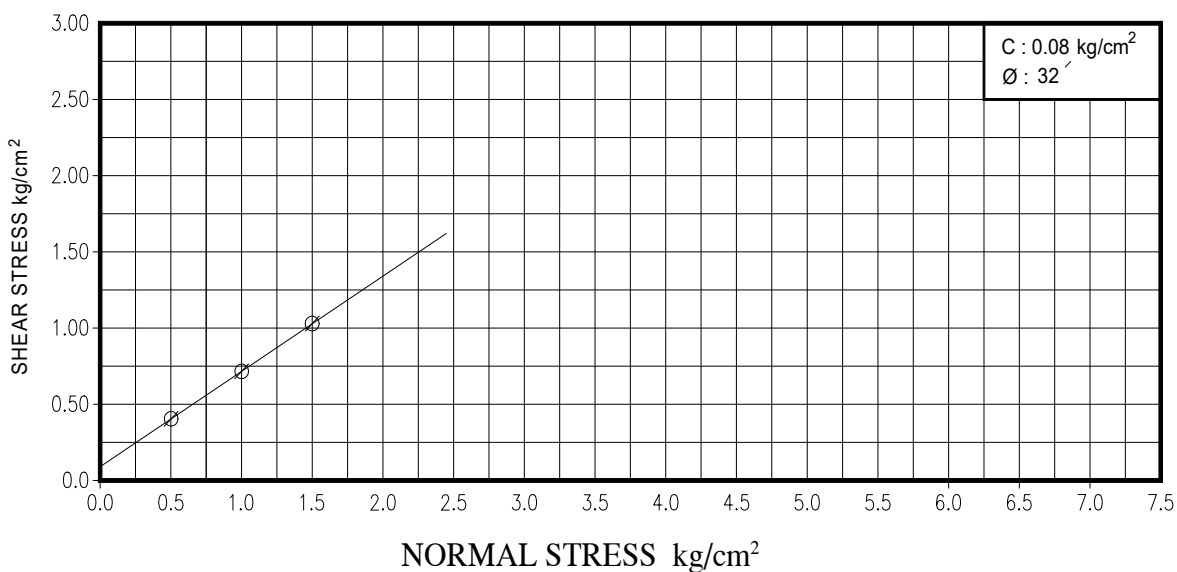
Depth (m):- 3.00



DIRECT SHEAR TEST CURVE (DS)

BH NO. 9

Depth (m):- 4.50





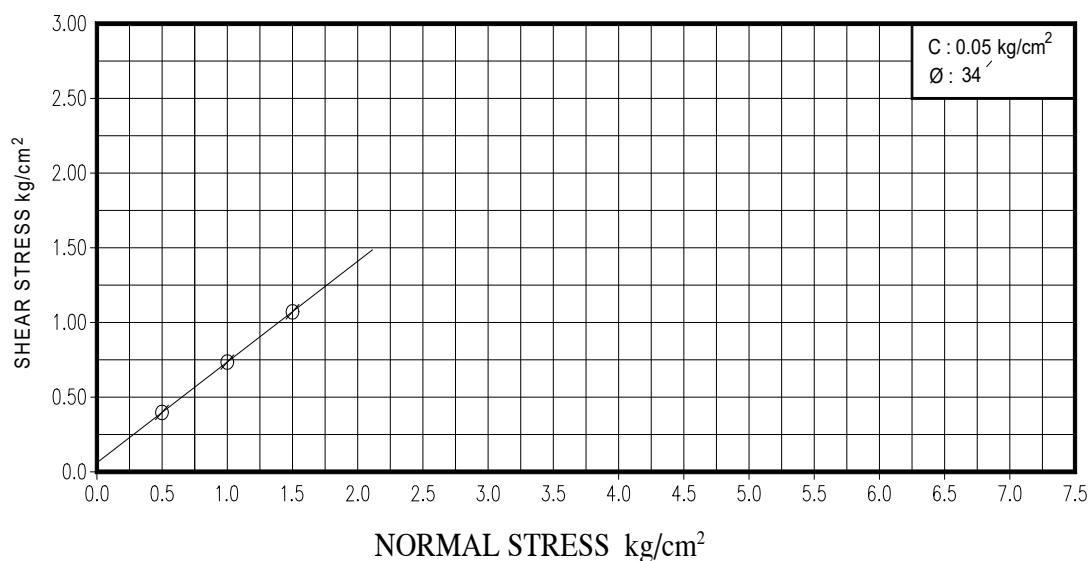
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 9

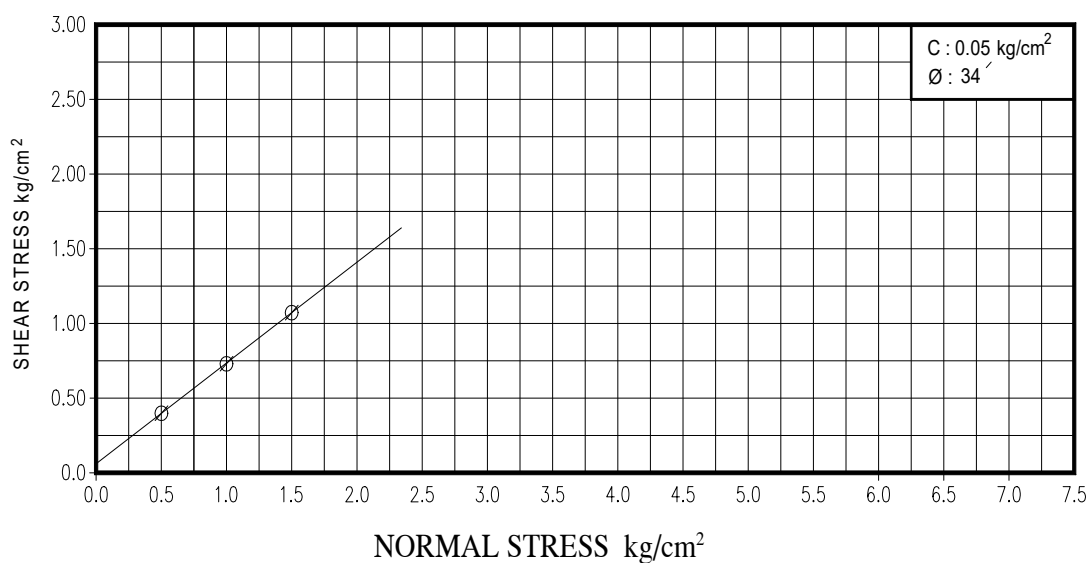
Depth (m):- 12.00



DIRECT SHEAR TEST CURVE (DS)

BH NO. 10

Depth (m):- 3.00





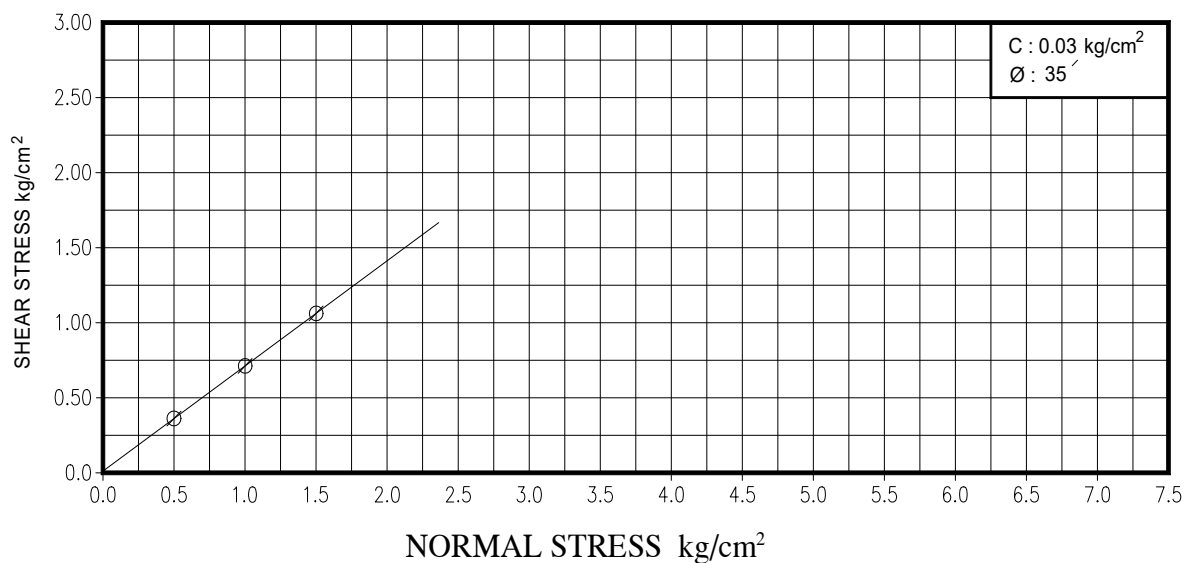
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 10

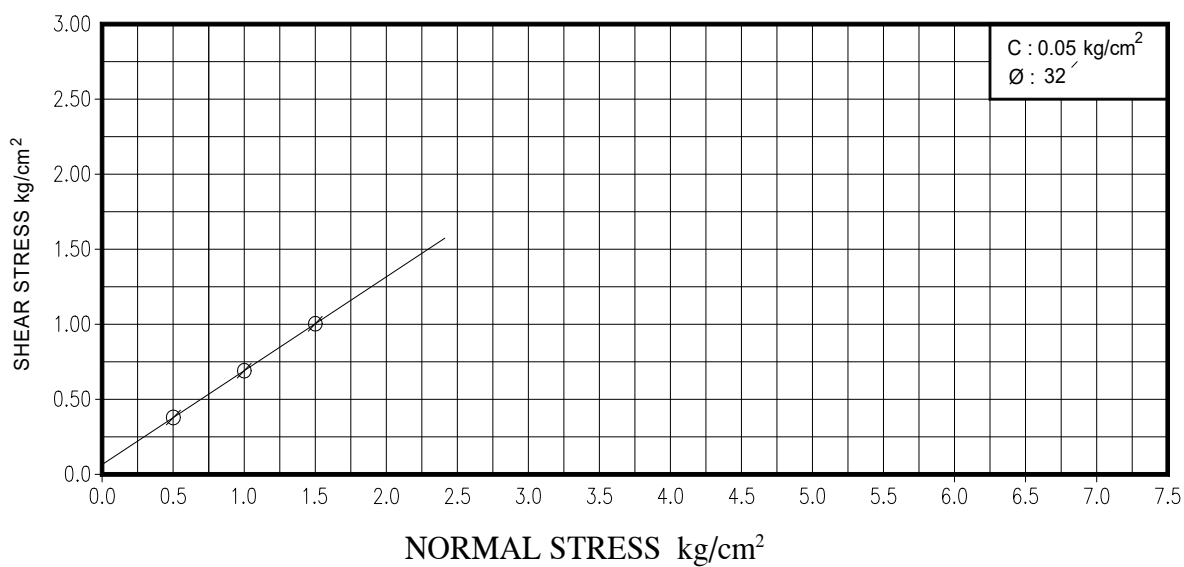
Depth (m):- 12.00



DIRECT SHEAR TEST CURVE (DS)

BH NO. 11

Depth (m):- 15.00





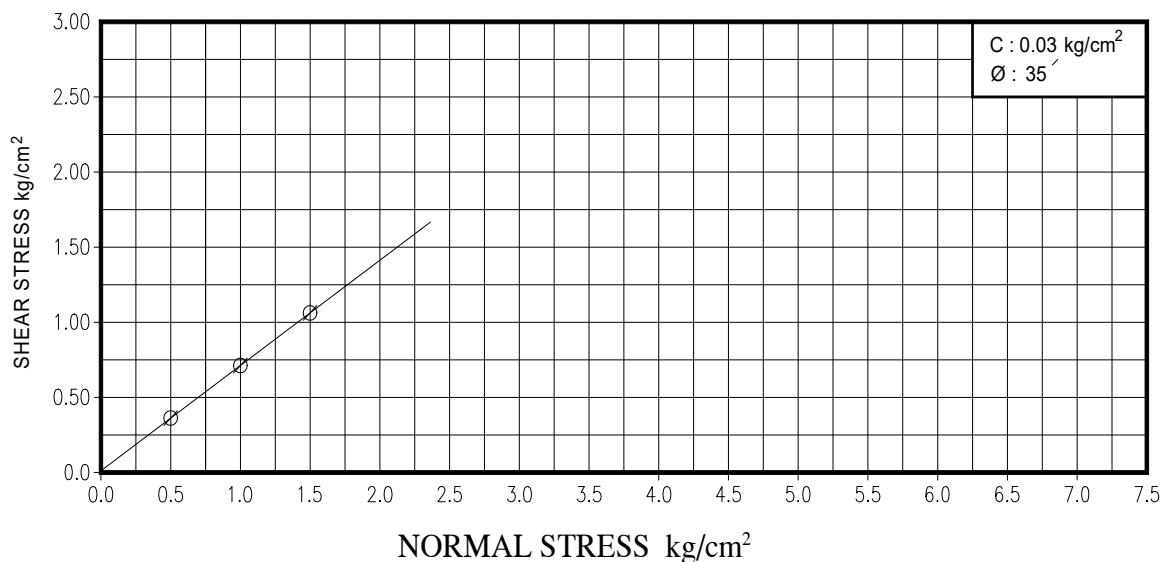
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 11

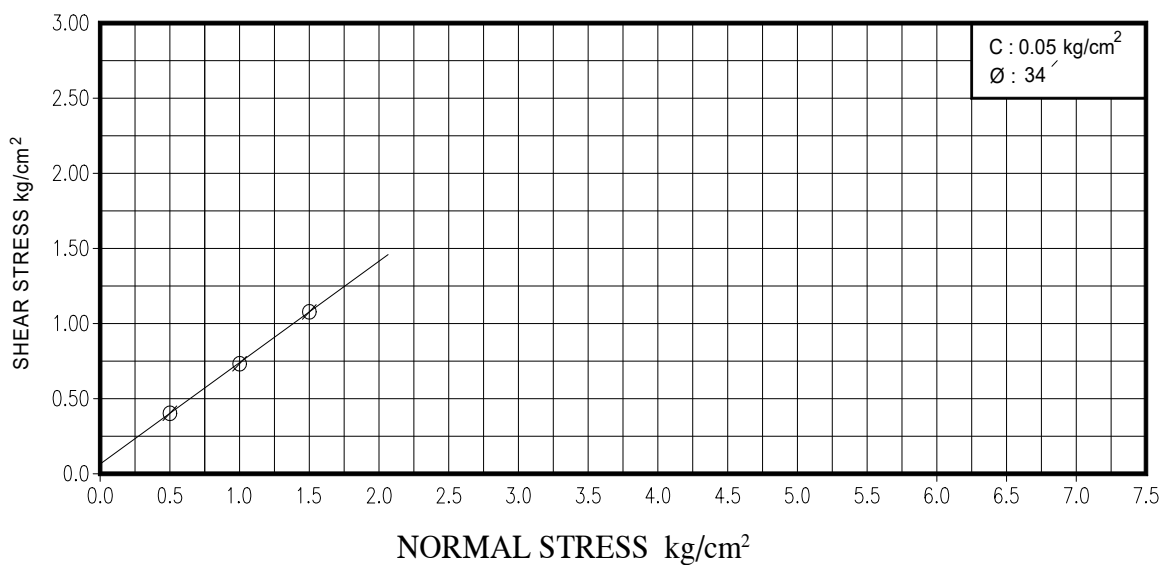
Depth (m):- 24.00



DIRECT SHEAR TEST CURVE (DS)

BH NO. 12

Depth (m):- 3.00





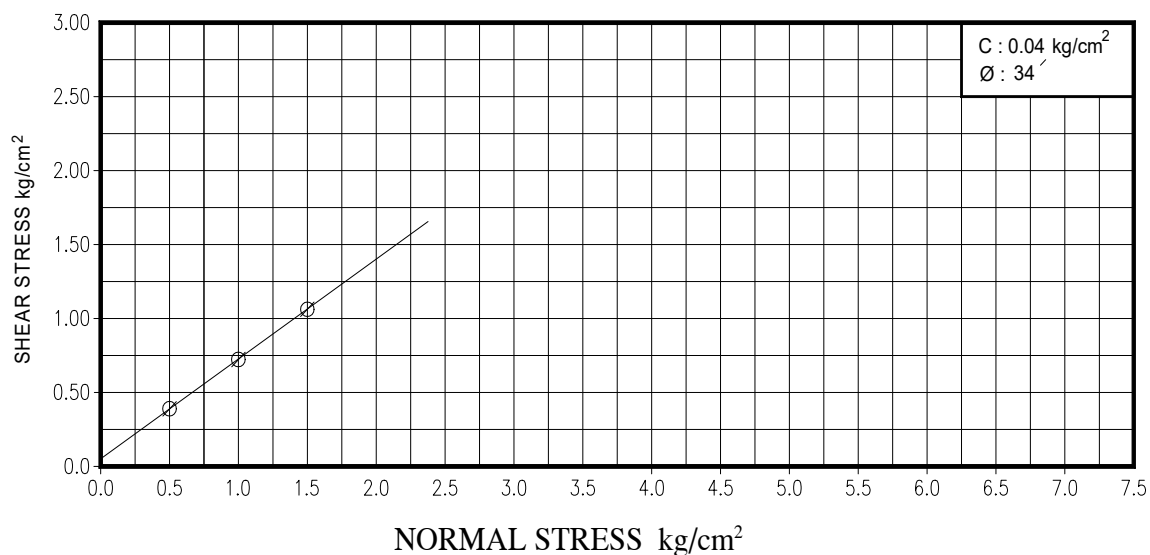
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 12

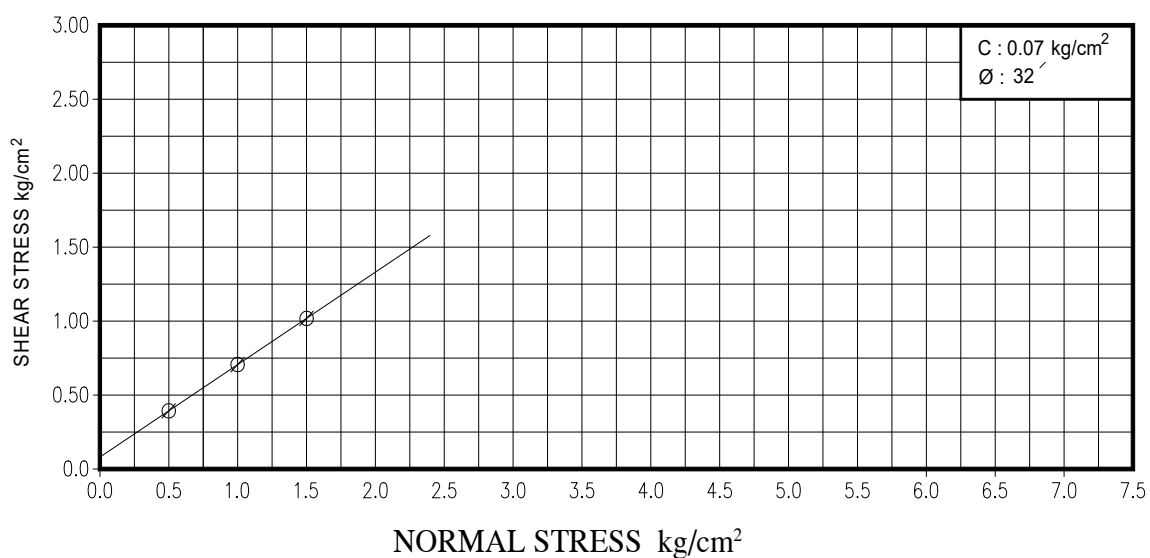
Depth (m):- 6.00



DIRECT SHEAR TEST CURVE (DS)

BH NO. 13

Depth (m):- 3.00





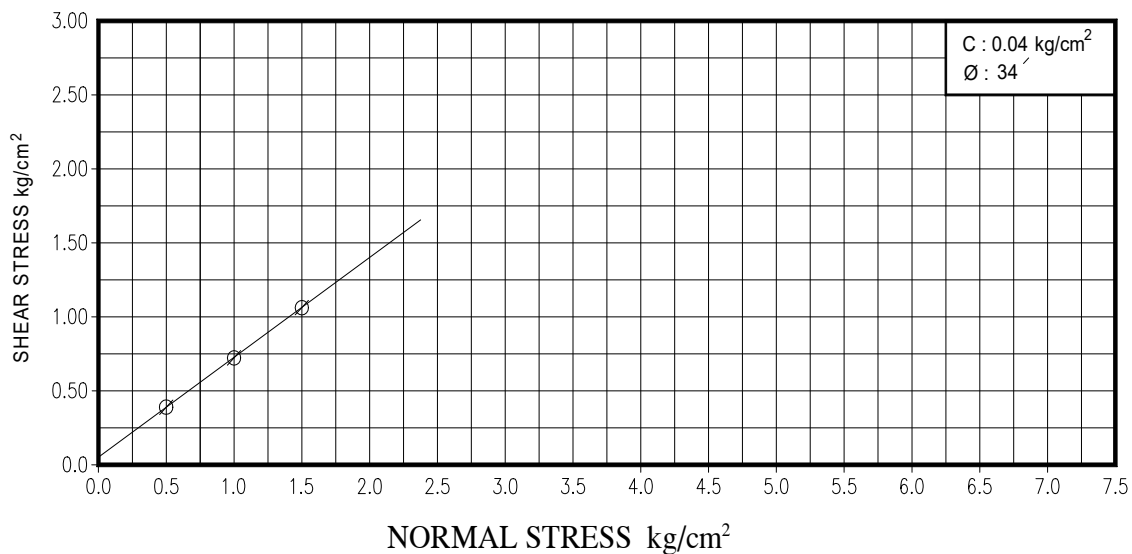
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 13

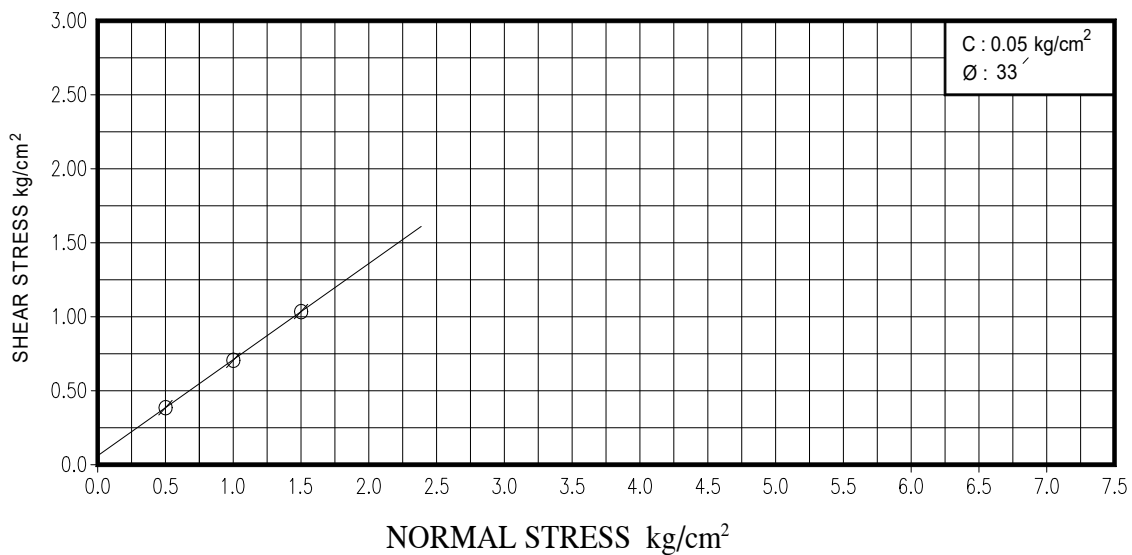
Depth (m):- 12.00



DIRECT SHEAR TEST CURVE (DS)

BH NO. 14

Depth (m):- 3.00





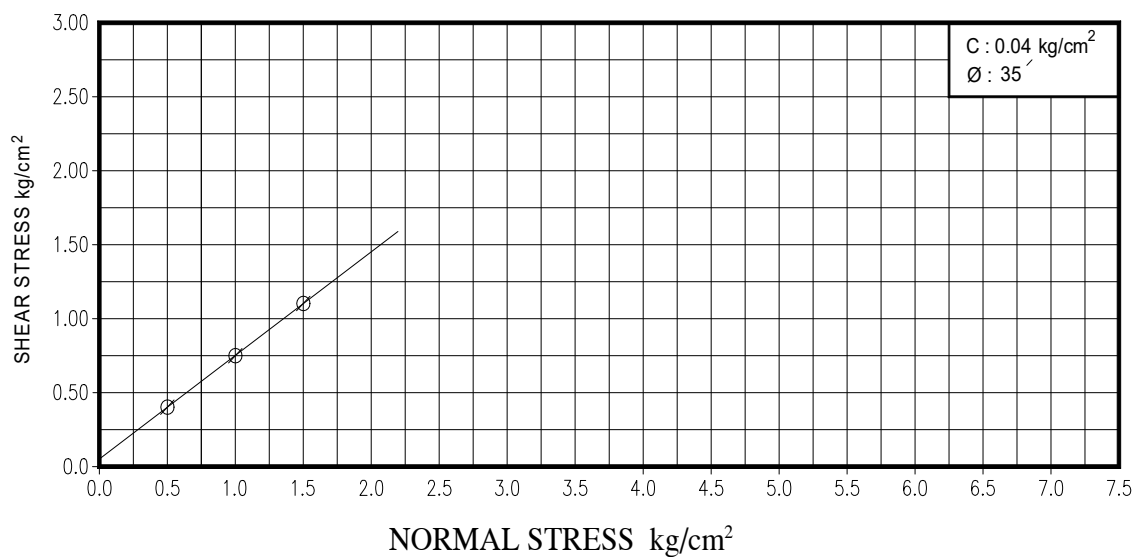
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 15

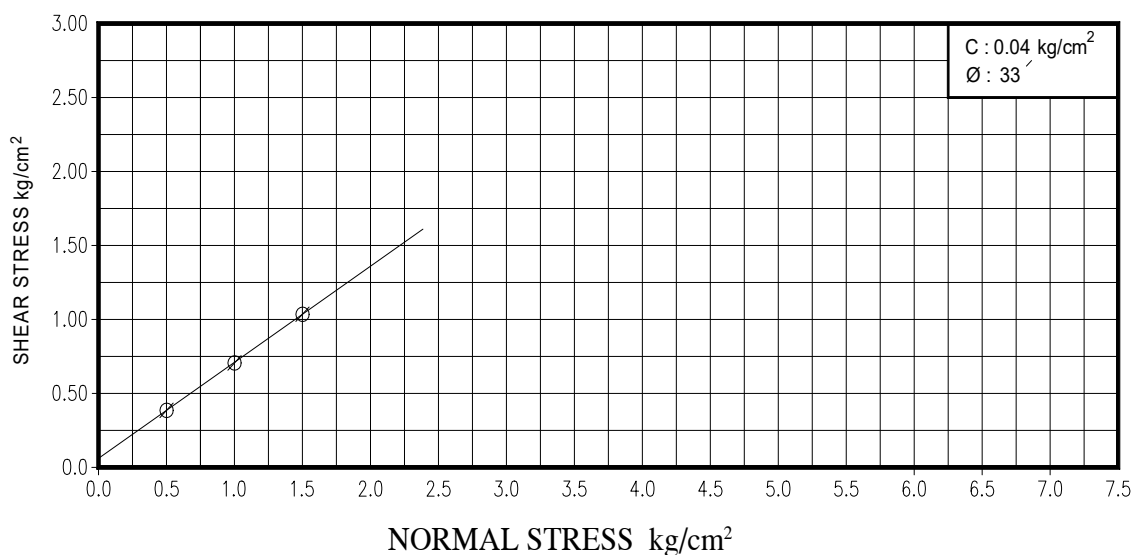
Depth (m):- 6.00



DIRECT SHEAR TEST CURVE (DS)

BH NO. 15

Depth (m):- 21.00





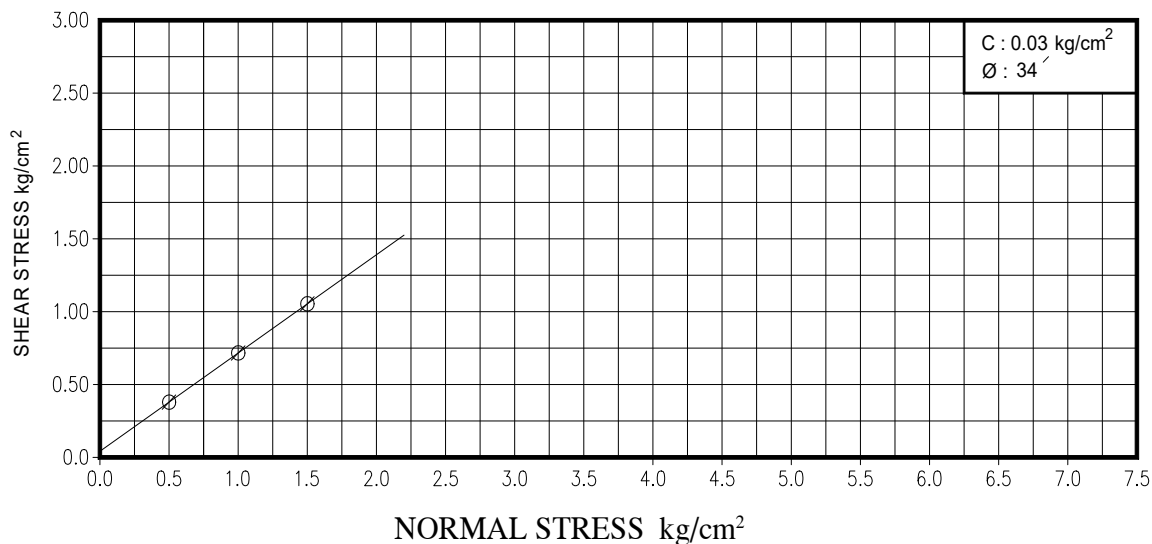
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 16

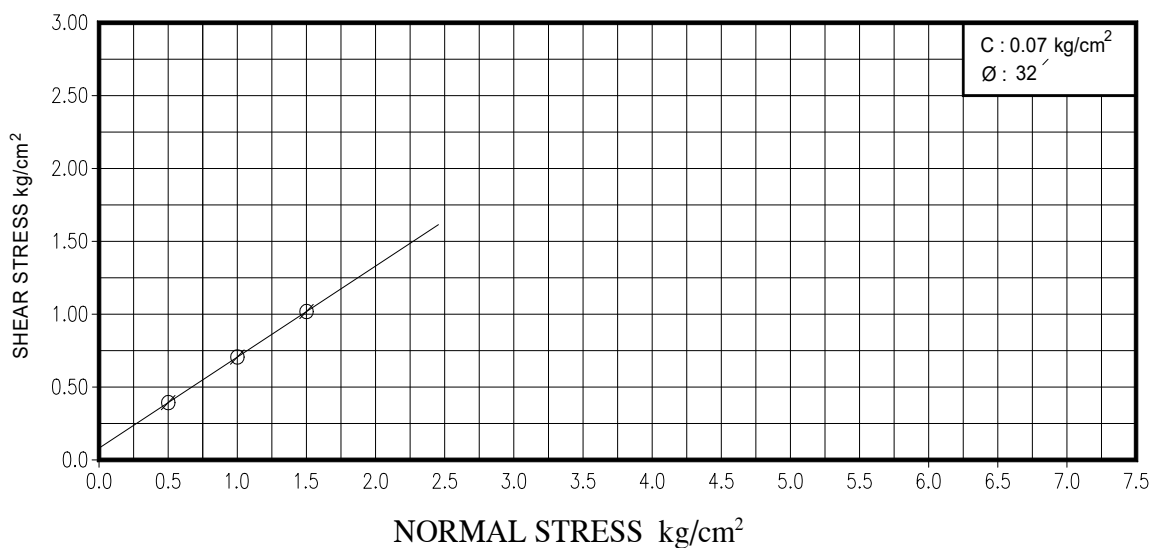
Depth (m):- 1.50



DIRECT SHEAR TEST CURVE (DS)

BH NO. 16

Depth (m):- 4.50





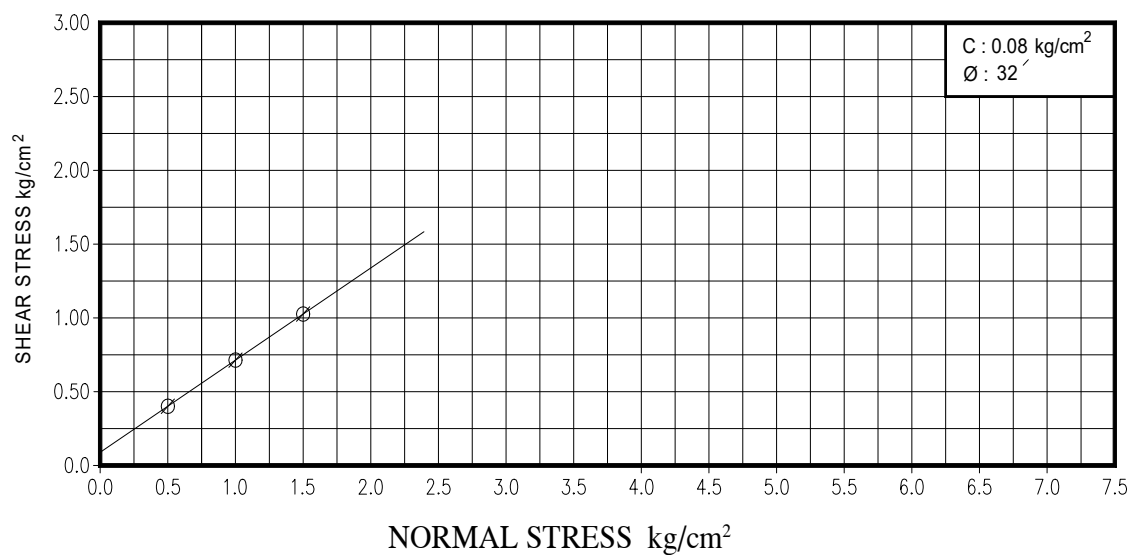
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 17

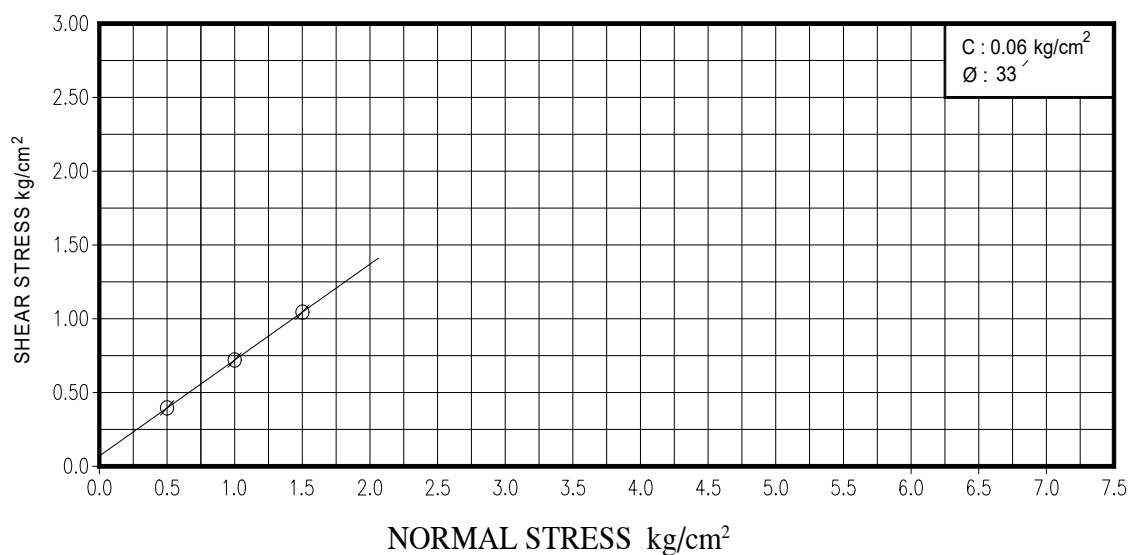
Depth (m):- 1.50



DIRECT SHEAR TEST CURVE (DS)

BH NO. 17

Depth (m):- 3.00





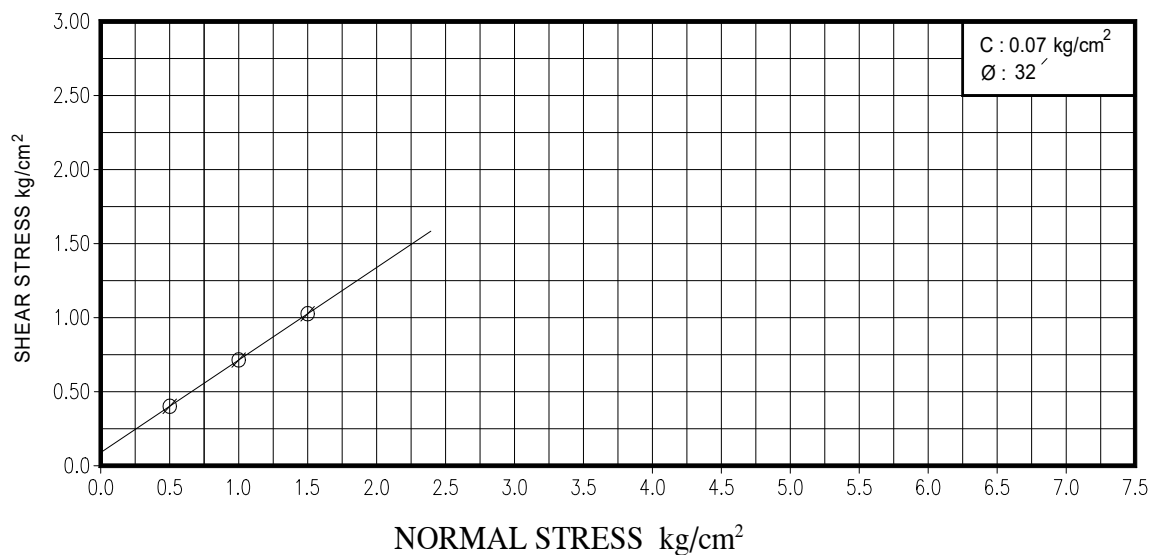
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 18

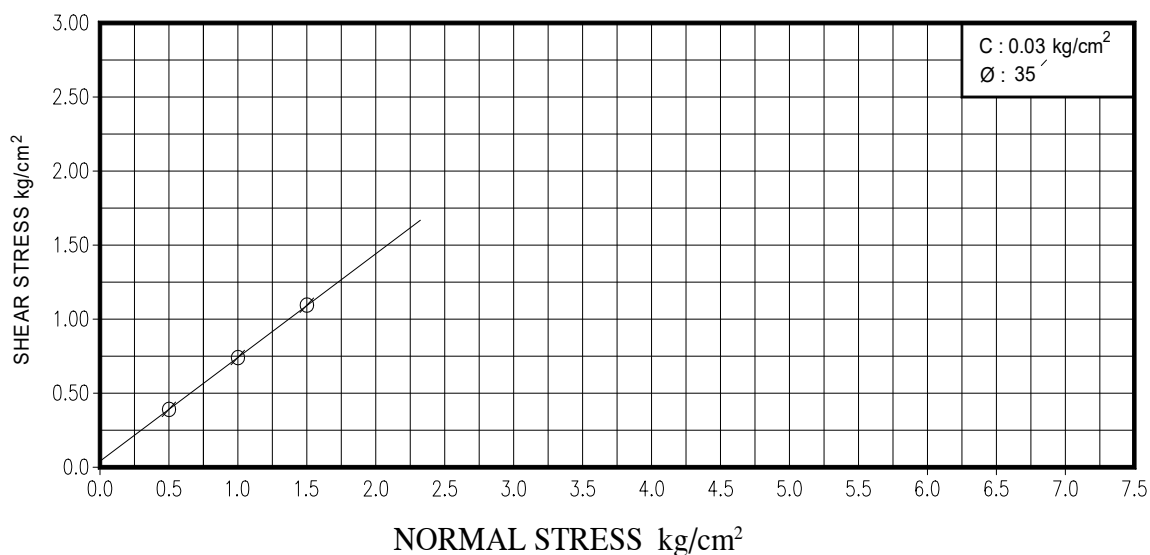
Depth (m):- 3.00



DIRECT SHEAR TEST CURVE (DS)

BH NO. 21

Depth (m):- 4.50





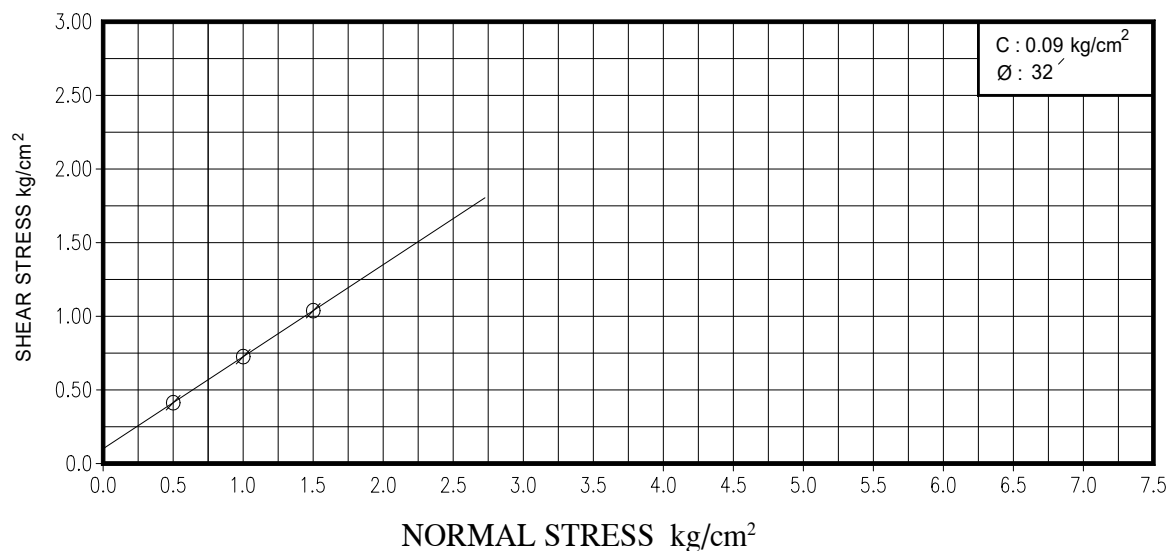
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 21

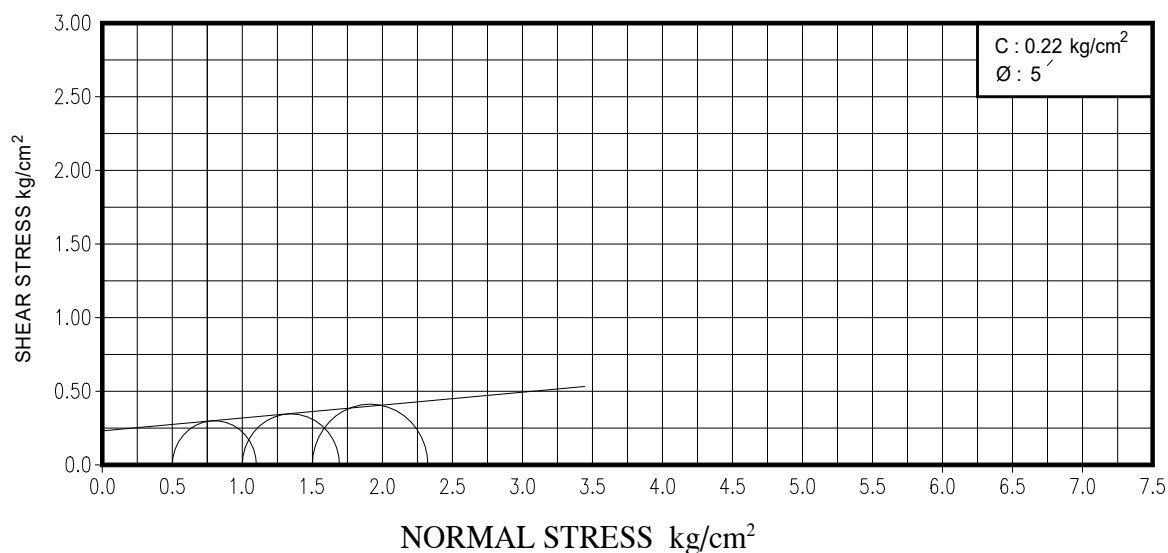
Depth (m):- 9.00



TRIAXIAL SHEAR TEST CURVE (UU)

BH NO. 22

Depth (m):- 4.00





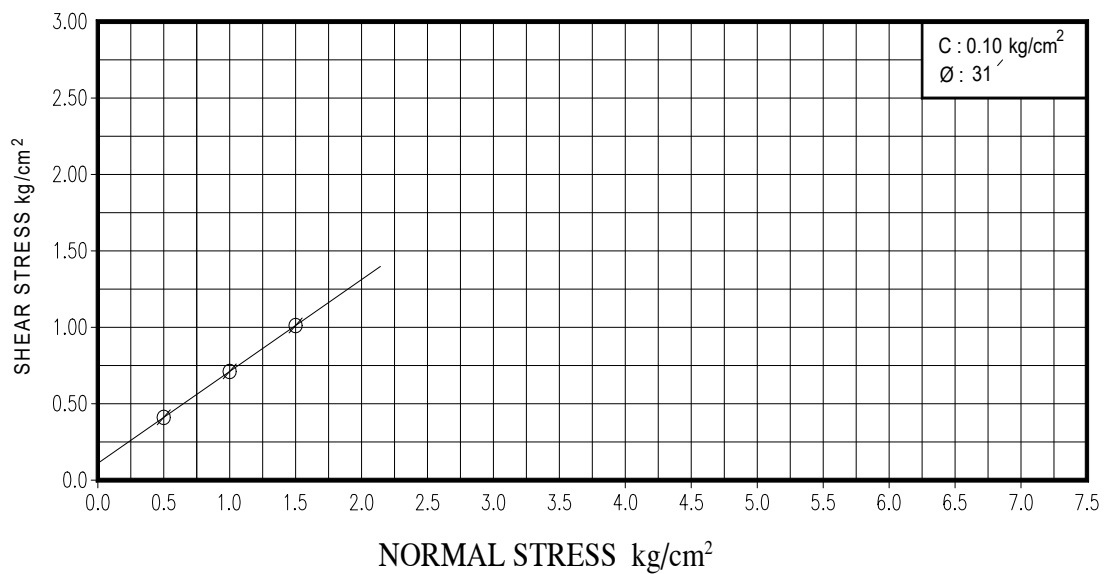
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 23

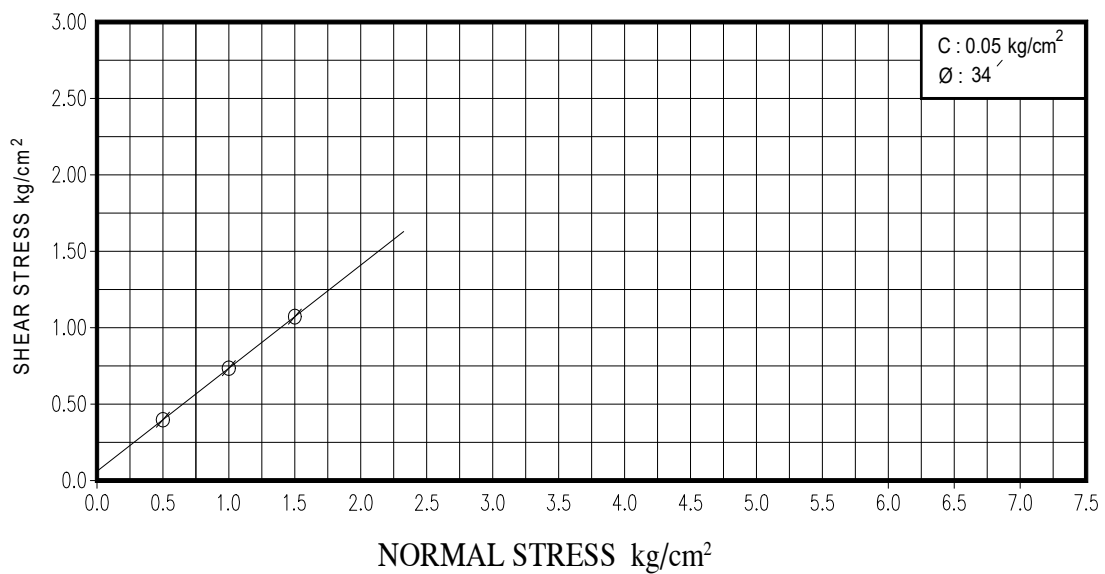
Depth (m):- 1.50



DIRECT SHEAR TEST CURVE (DS)

BH NO. 23

Depth (m):- 3.00





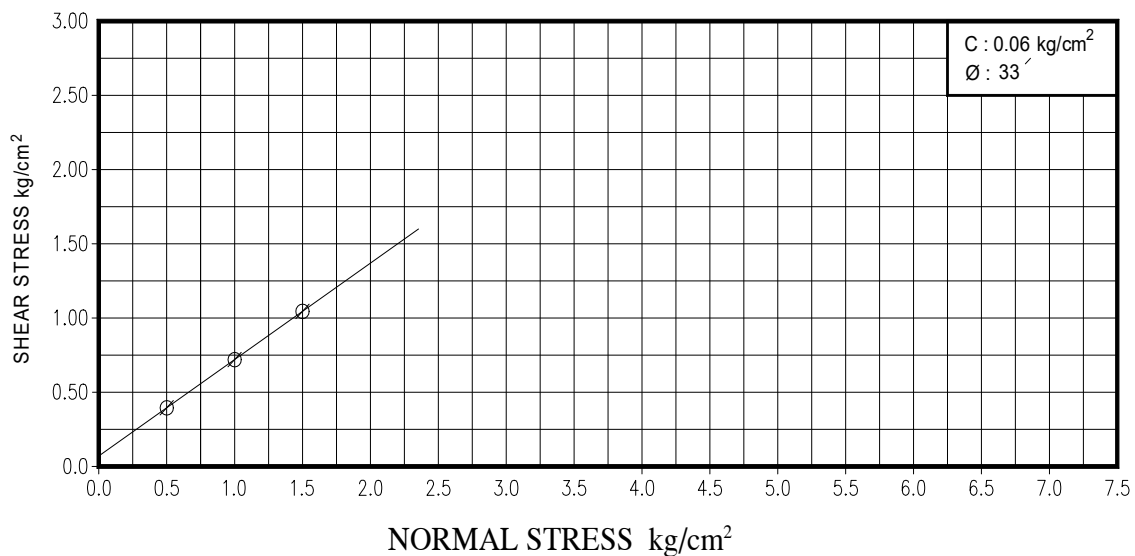
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

DIRECT SHEAR TEST CURVE (DS)

BH NO. 24

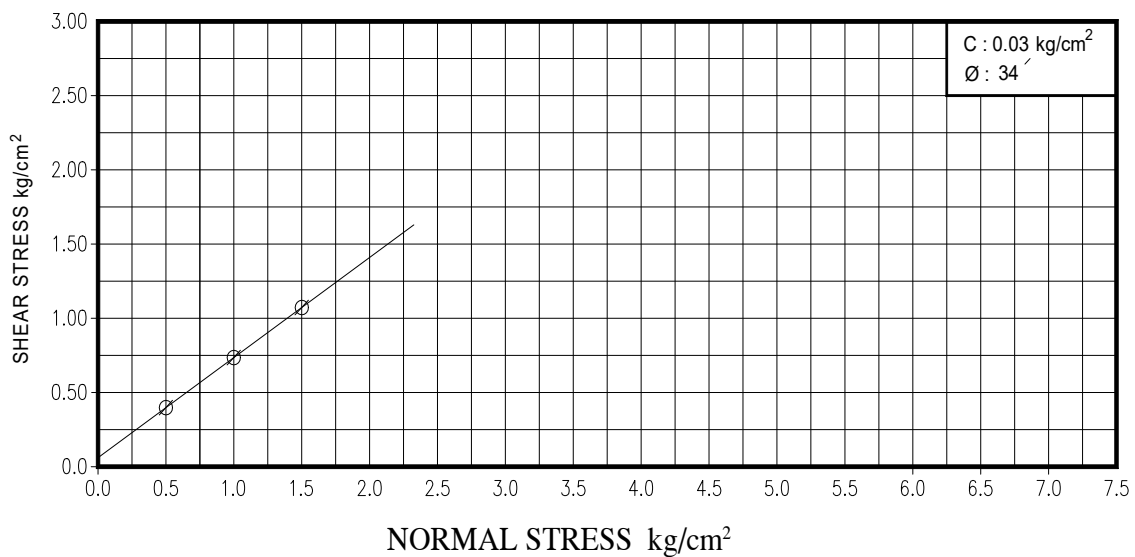
Depth (m):- 4.50



DIRECT SHEAR TEST CURVE (DS)

BH NO. 24

Depth (m):- 10.50





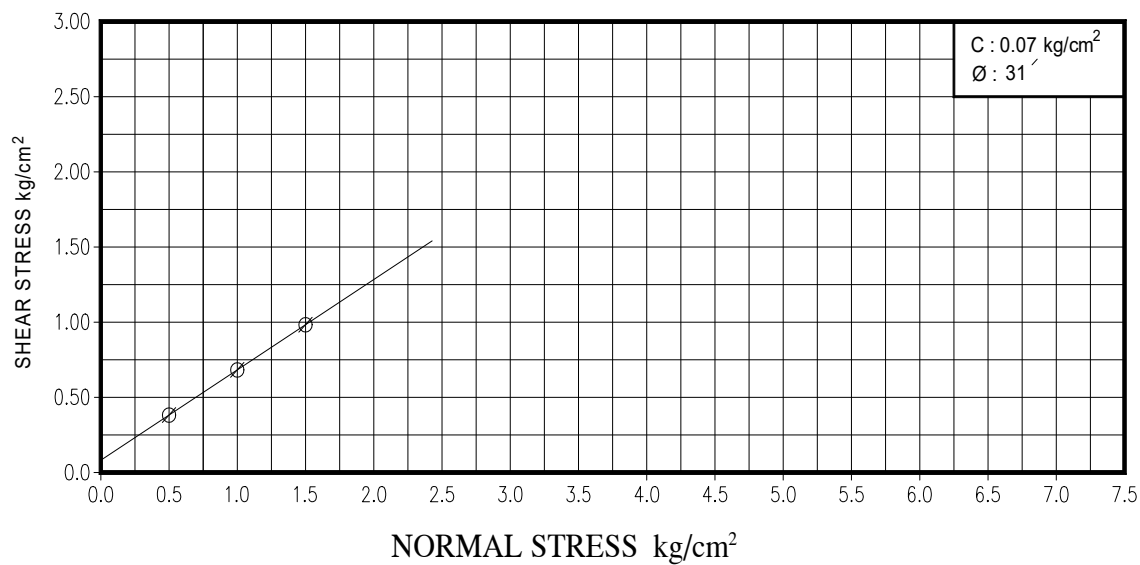
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
OWNER	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
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DIRECT SHEAR TEST CURVE (DS)

BH NO. 25

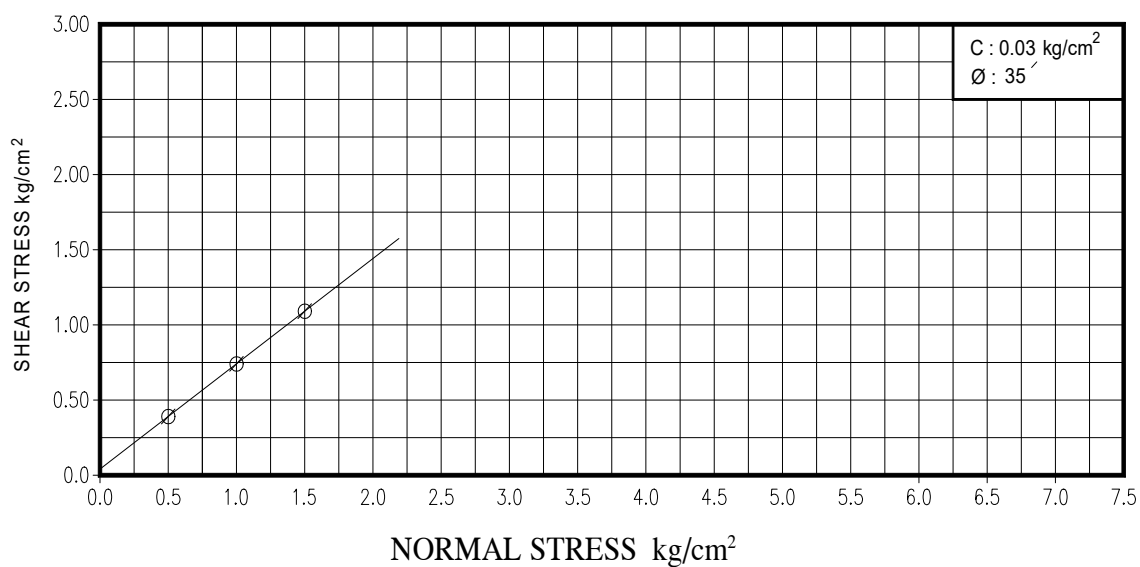
Depth (m):- 3.00

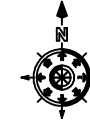
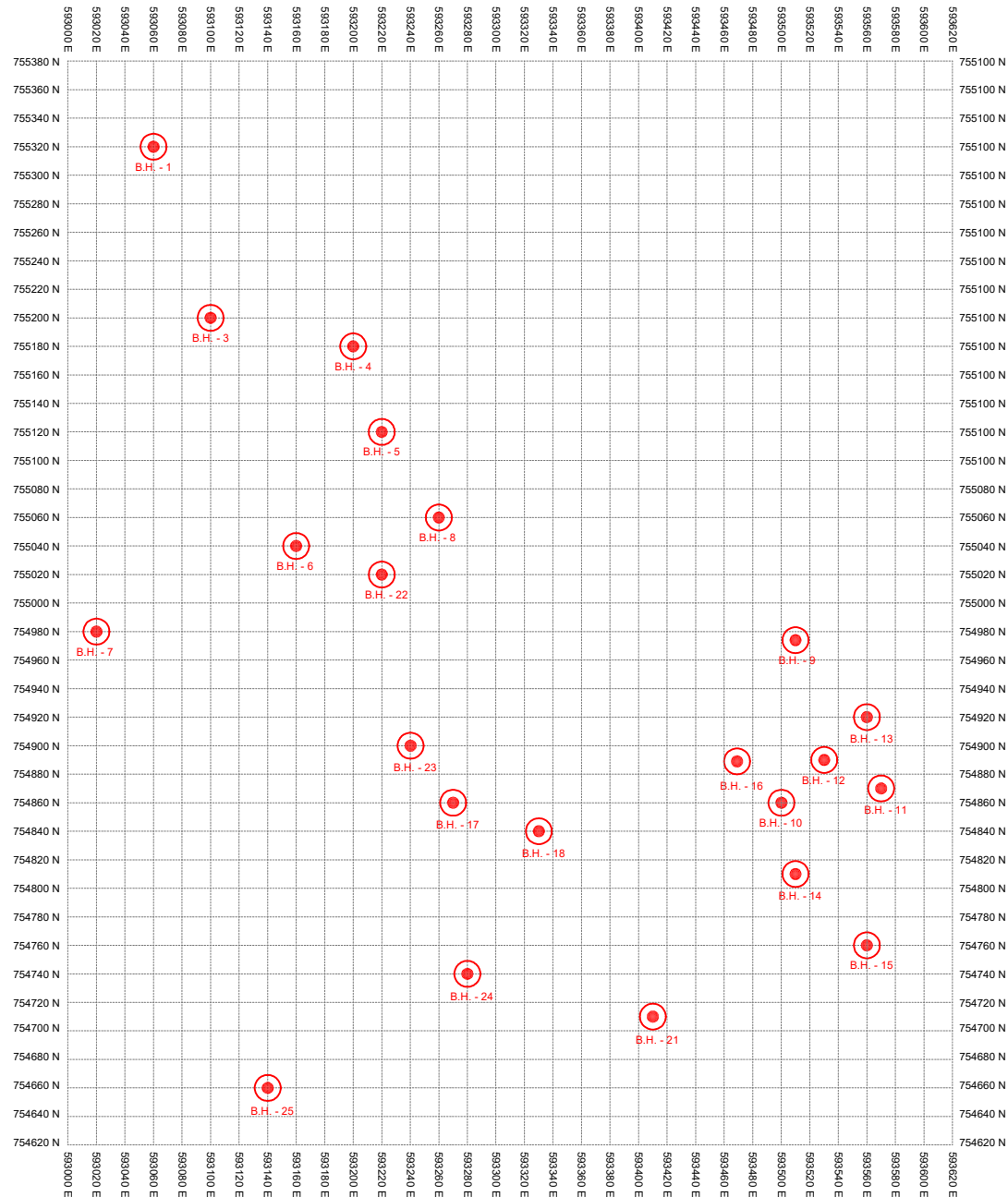


DIRECT SHEAR TEST CURVE (DS)

BH NO. 25

Depth (m):- 6.00





BH No.	Co-ordinate		RL.(M)
	Easting	Northing	
BH - 01	E 593060.000	N 755320.000	7.727
BH - 03	E 593100.000	N 755200.000	7.280
BH - 04	E 593200.000	N 755180.000	5.506
BH - 05	E 593220.000	N 755120.000	5.324
BH - 06	E 593160.000	N 755040.000	5.904
BH - 07	E 593020.000	N 754980.000	44.406
BH - 08	E 593260.000	N 755060.000	5.284
BH - 09	E 593510.000	N 754974.000	5.146
BH - 10	E 593500.000	N 754860.000	5.528
BH - 11	E 593570.000	N 754870.000	5.443
BH - 12	E 593530.000	N 754890.000	5.380
BH - 13	E 593560.000	N 754920.000	5.380
BH - 14	E 593510.000	N 754810.000	5.413
BH - 15	E 593560.000	N 754760.000	5.138
BH - 16	E 593469.000	N 754889.000	5.335
BH - 17	E 593270.000	N 754860.000	5.487
BH - 18	E 593330.000	N 754840.000	5.403
BH - 21	E 593410.000	N 754710.000	5.296
BH - 22	E 593220.000	N 755020.000	5.367
BH - 23	E 593240.000	N 754900.000	5.479
BH - 24	E 593280.000	N 754740.000	5.954
BH - 25	E 593140.000	N 754660.000	8.983

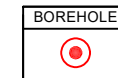


Fig-1.: Borehole Location Plan for 108 MW Gas based Power Plant Project

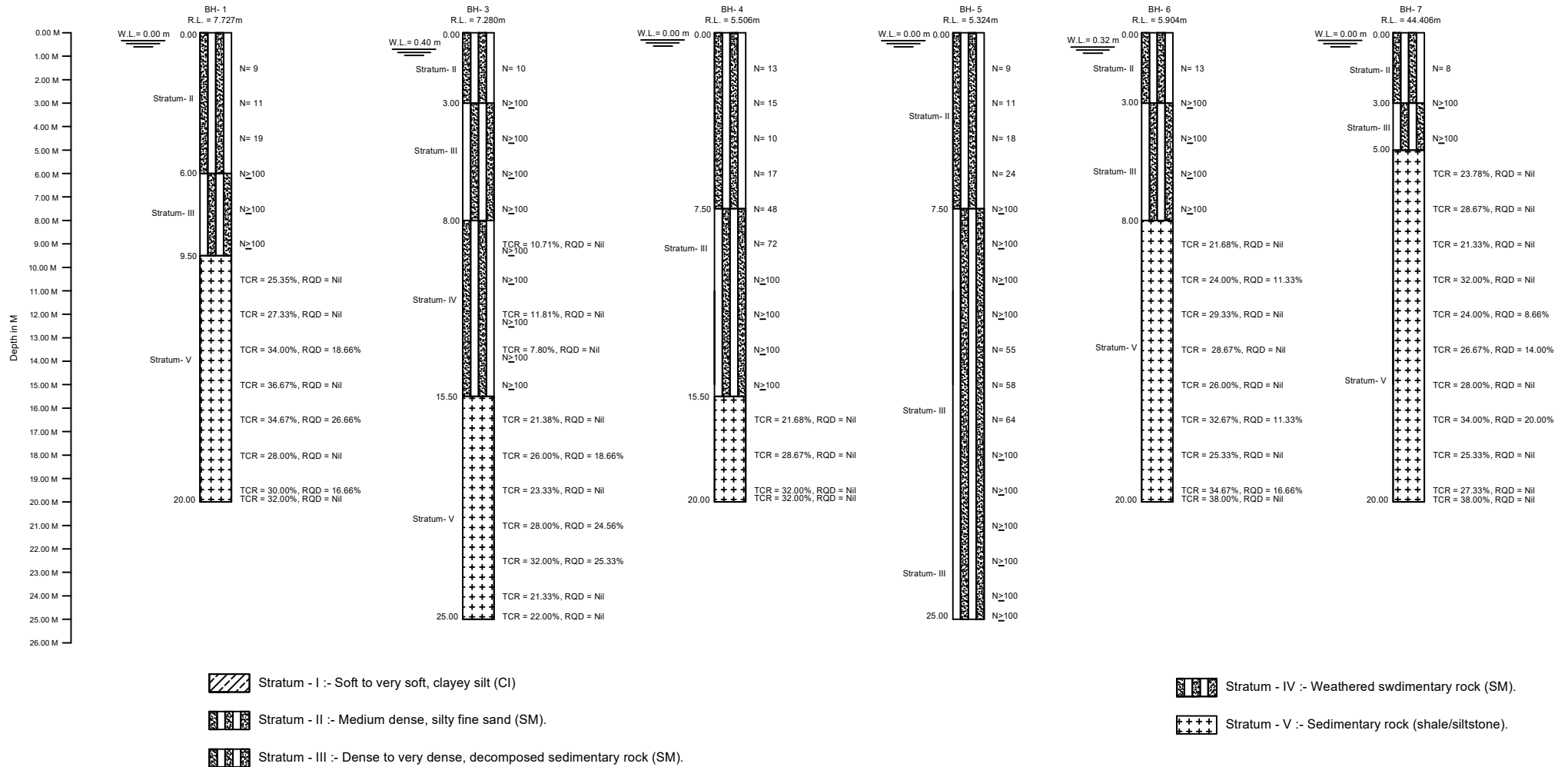


Fig. 2a:- Graphical Borehole Log for 108 MW Gas based Power Plant Project.

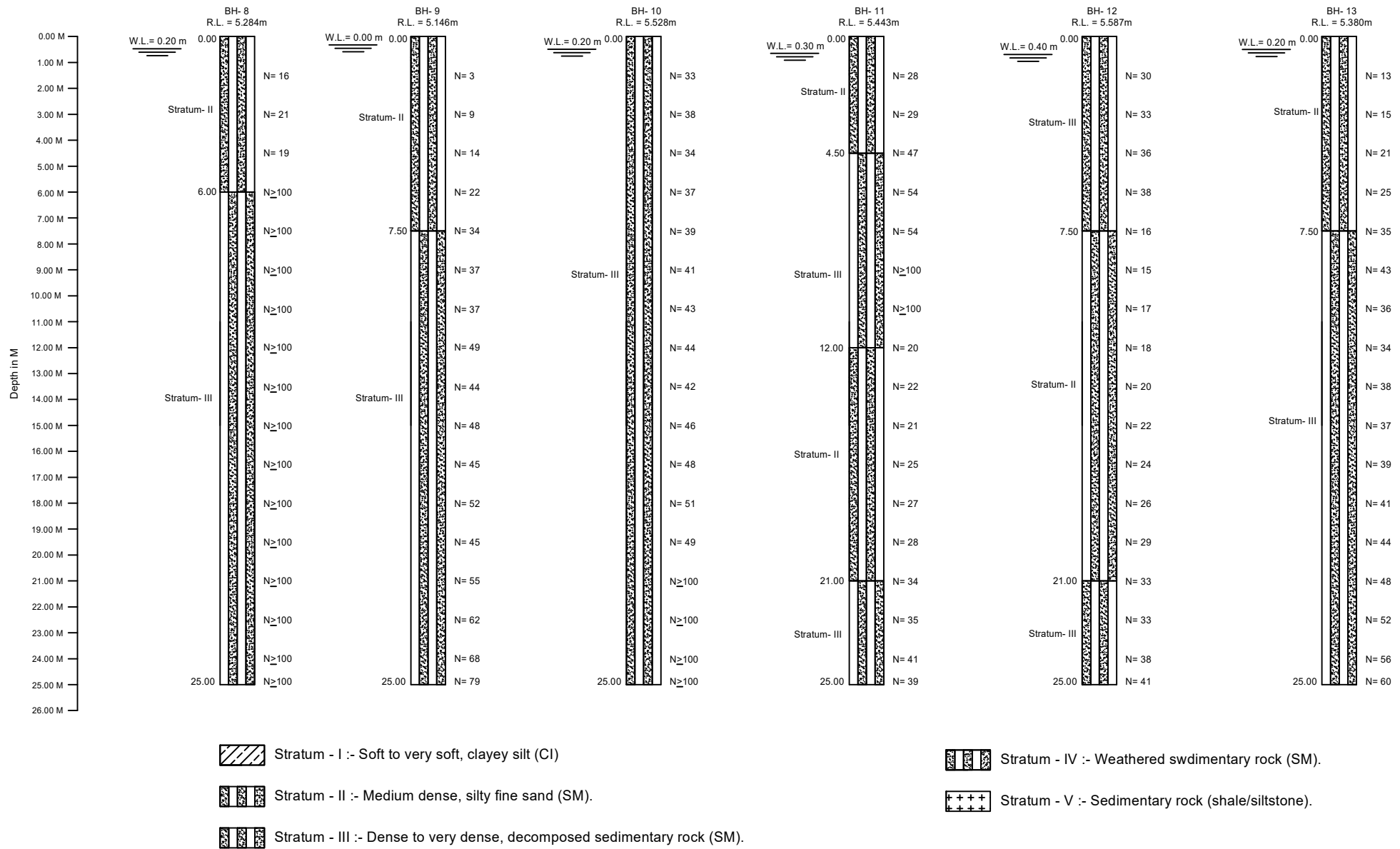


Fig. 2b:- Graphical Borehole Log for 108 MW Gas based Power Plant Project.

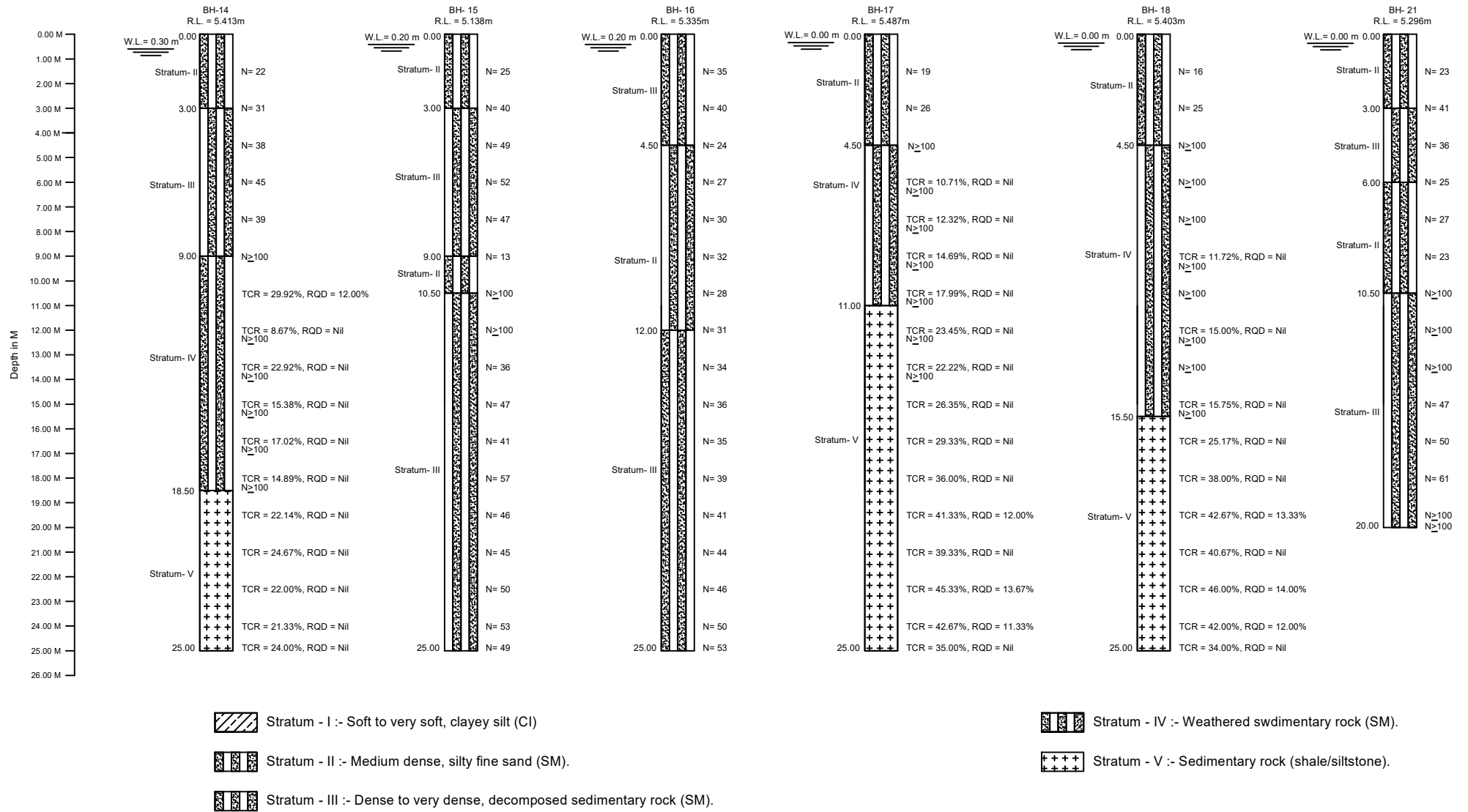


Fig. 2c:- Graphical Borehole Log for 108 MW Gas based Power Plant Project.

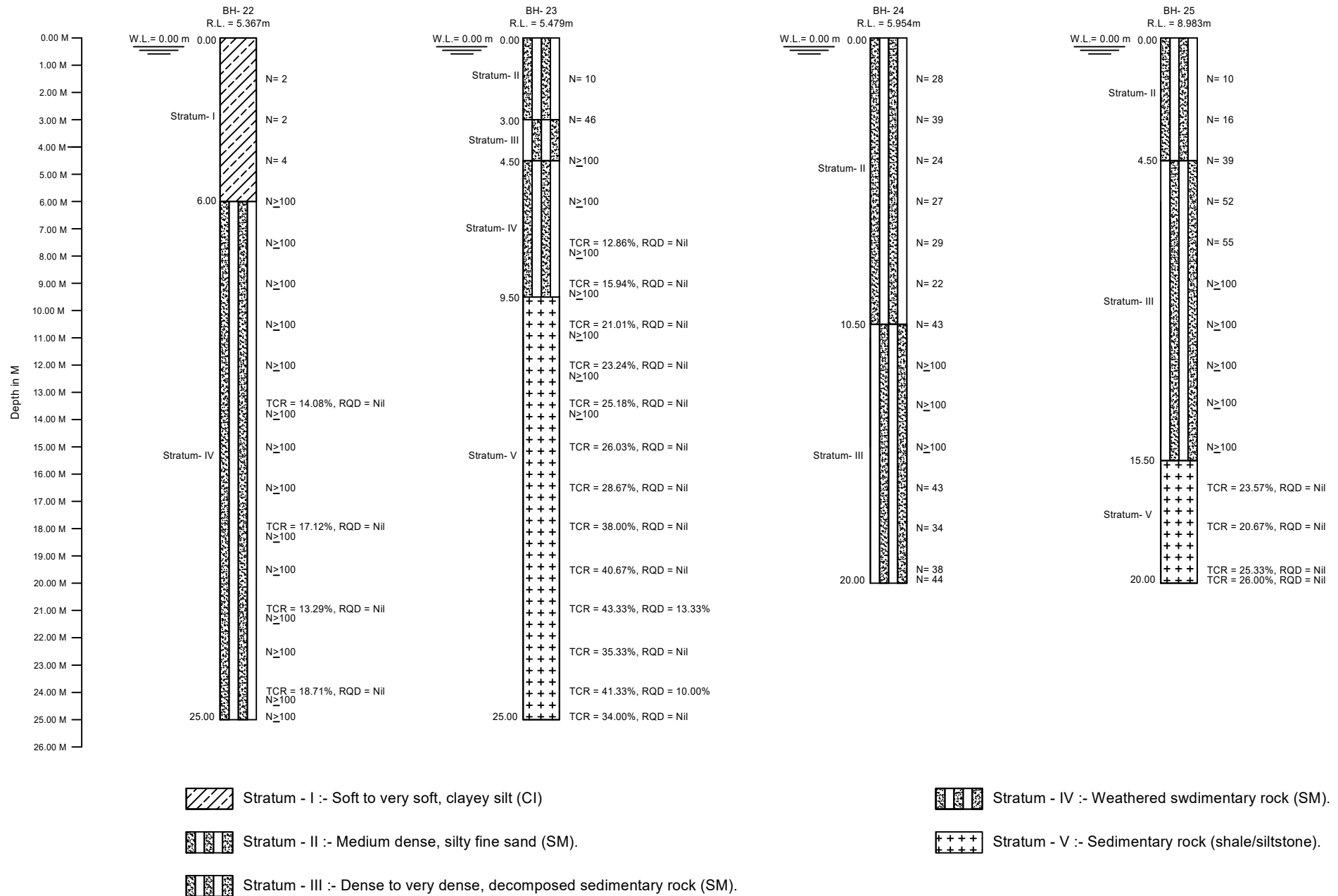


Fig. 2d:- Graphical Borehole Log for 108 MW Gas based Power Plant Project.

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

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PART – 2

REPORT ON EARTH RESISTIVITY TEST

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
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Report on**Earth Resistivity Test for 108 MW Gas based Power Plant at Great Nicobar Island, India****CONTENTS**

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4.0 Details of Field Work	2
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GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
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1.0 Introduction

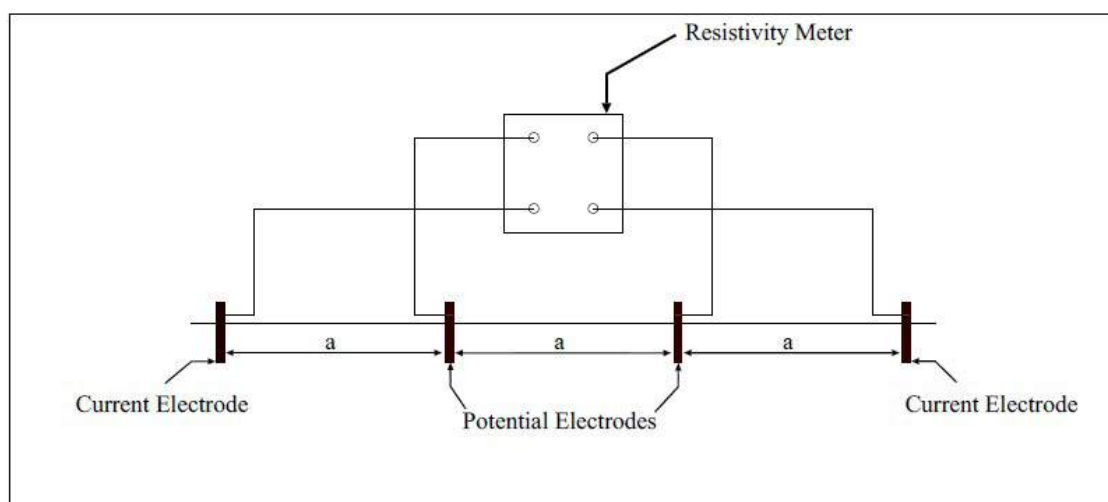
Earth resistivity test have been conducted at twelve locations in Galathea project site, for set-up power infrastructure in multiple phases with LNG based Gas Engine, PV Solar and Transmission System at Great Nicobar Island as per the mandate from MoP under the plan for Holistic Development of Great Nicobar Island. The test locations had been fixed up by the project authority.

2.0 Objective

The objective of the electrical resistivity test is to evaluate the parameters (resistivity value) required for designing the earth mat. For this purpose, principles of geophysics regarding resistivity survey were applied.

3.0 Methodology

The electrical resistivity survey has been conducted adopting the Wenner's electrode configuration. In this configuration the electrical resistivity measurement are made using four electrode arranged in a straight line. These electrodes are uniformly spaced, i.e. the distance between any two adjacent electrodes is same. Current is introduced into the ground through the outer pair of electrodes known as current electrodes and centrally located pair of electrodes used for potential measurement is called potential electrodes.



Wenner Method For Electrical Resistivity Measurement

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Resistivity ρ of the ground can be obtained by using the expression:

$$\rho = 2 \pi a R$$

Where, ρ = Apparent resistivity of the ground

a = Electrode spacing

R = Resistance

The earth resistivity test has been carried out as per provisions of IS – 3043 – 1987.

4.0 Details of Field Work

Fieldwork has been carried out using resistivity meter, electrodes and rubber-insulated wire. Resistivity meter directly reads the resistance.

Electrical Resistivity test has been conducted on 07.05.2025 to 09.05.2025. Twelve electrical resistivity tests have been conducted at proposed site area. Resistivity test has been conducted at the said location along two perpendicular lines parallel to coordinate axes. Electrode spacing (a) was taken as 1.0 m, 2.0 m, 3.0 m, 4.0 m, and 5.0 m, respectively. Data will be presented up to 5.0 meter spacing.



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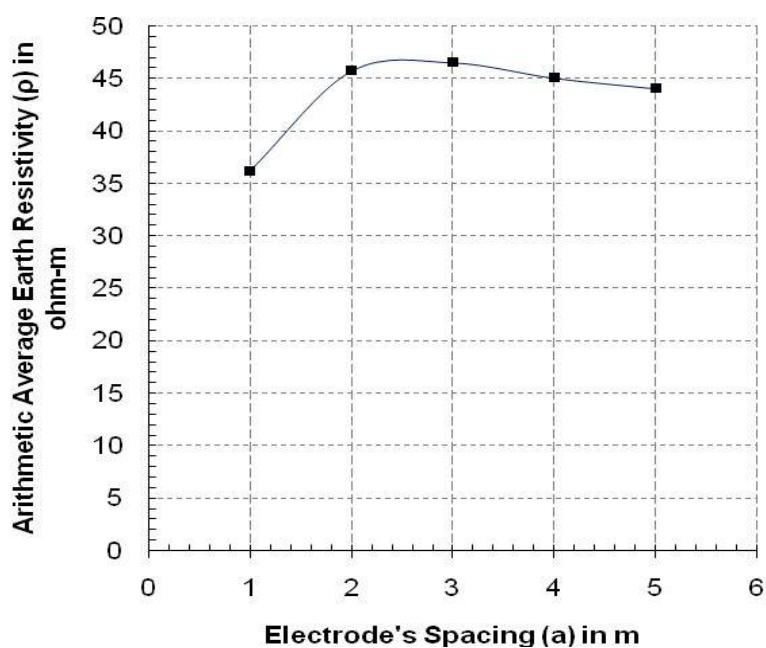
5.0 Results

Results of the multidirectional resistivity tests have been summarized and presented below in tabular form.

ERT – 01

Co-ordinate: E 593510.00, N 754740.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N – S	E – W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	31.429	40.920	36.174
2	2	42.743	48.651	45.697
3	3	45.069	47.897	46.483
4	4	45.509	44.503	45.006
5	5	42.429	45.571	44.000



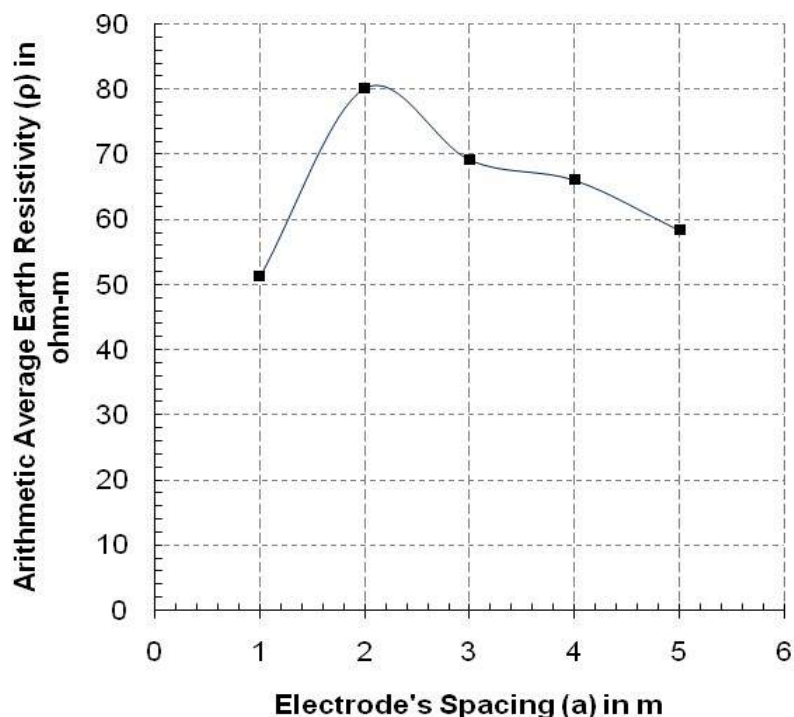
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ERT – 02

Co-ordinate: E 593590.00, N 754770.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N-S	E-W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	50.097	52.297	51.197
2	2	73.669	86.491	80.080
3	3	65.057	73.166	69.111
4	4	64.617	67.383	66.000
5	5	54.057	62.543	58.300



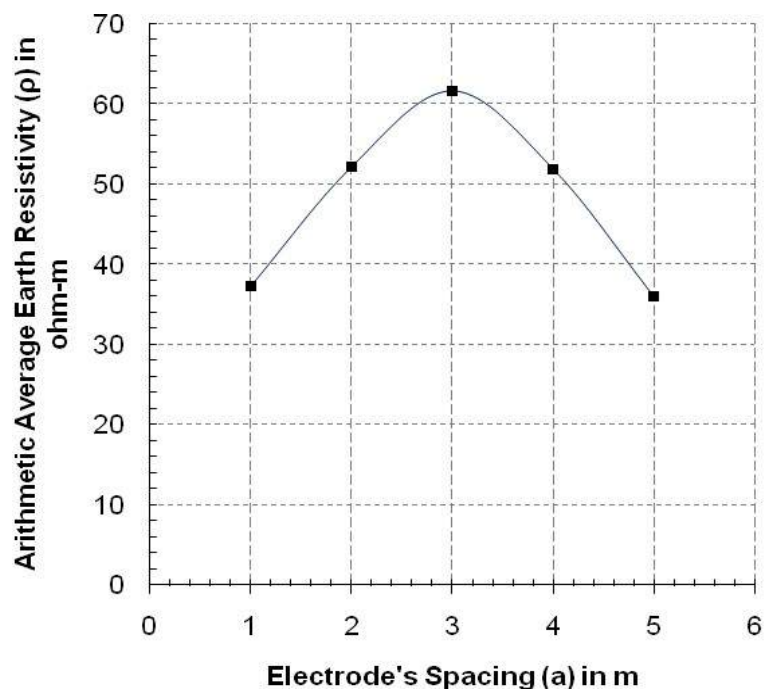
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CLIENT	NTPC Ltd.
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ERT – 03

Co-ordinate: E 593500.00, N 754765.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N-S	E-W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	36.520	38.029	37.274
2	2	52.171	52.171	52.171
3	3	61.286	62.040	61.663
4	4	49.783	54.057	51.920
5	5	33.629	38.343	35.986



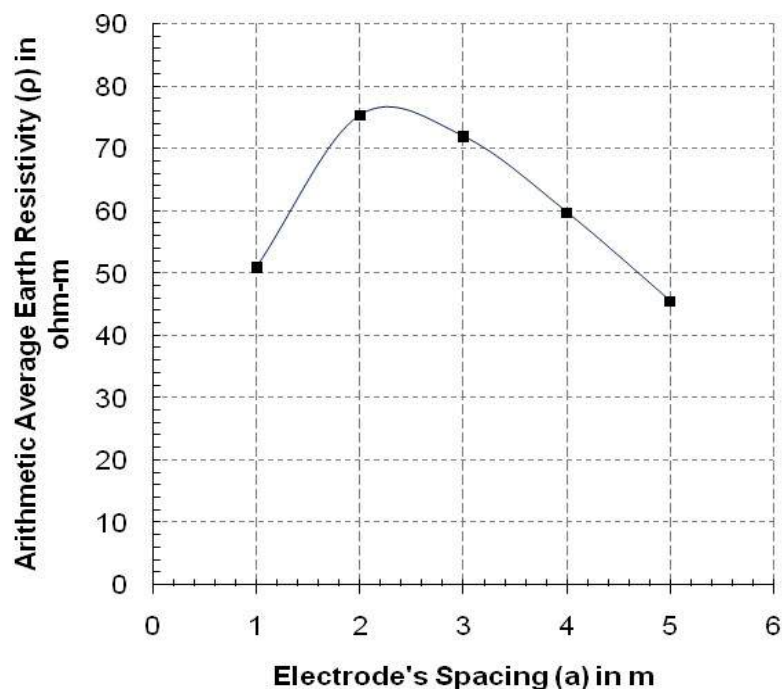
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ERT – 04

Co-ordinate: E 593580.00, N 754785.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N-S	E-W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	51.103	50.851	50.977
2	2	72.663	78.194	75.429
3	3	75.240	68.829	72.034
4	4	59.337	60.343	59.840
5	5	48.400	42.743	45.571



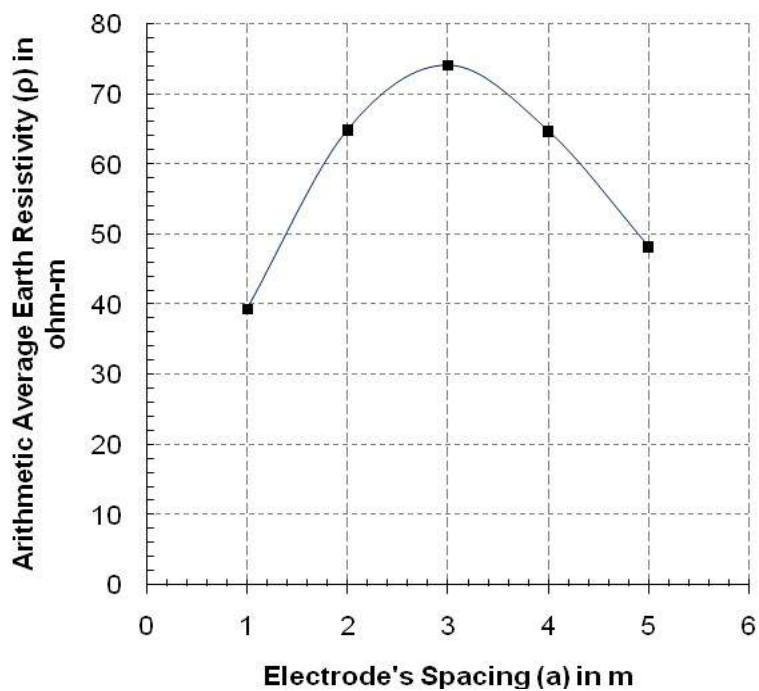
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CLIENT	NTPC Ltd.
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ERT – 05

Co-ordinate: E 593490.00, N 754785.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N-S	E-W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	39.034	39.789	39.411
2	2	66.126	63.737	64.931
3	3	75.429	72.789	74.109
4	4	65.874	63.611	64.743
5	5	50.914	45.571	48.243



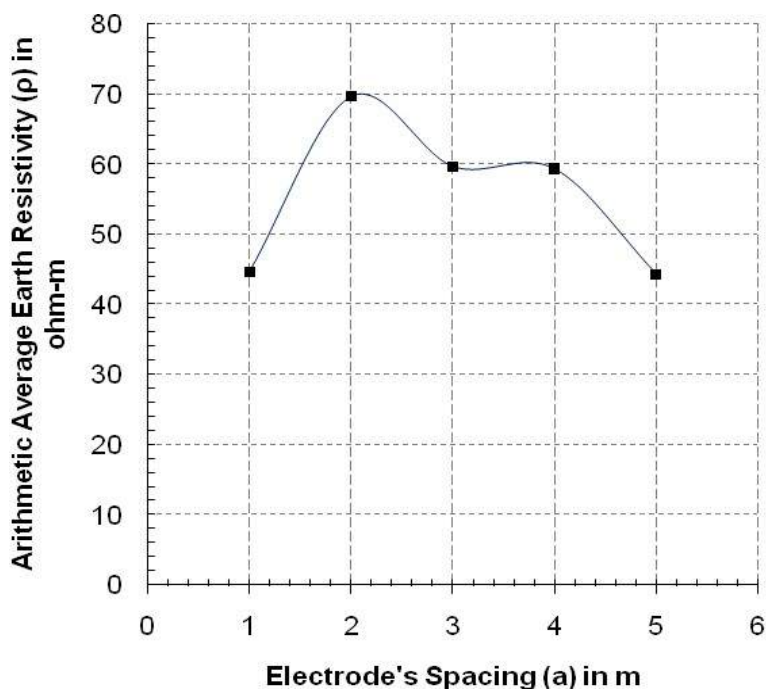
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PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
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DATE	September, 2025

ERT – 06

Co-ordinate: E 593560.00, N 754805.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N-S	E-W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	45.446	43.811	44.629
2	2	68.640	70.651	69.646
3	3	58.646	60.720	59.683
4	4	57.074	61.600	59.337
5	5	46.514	42.114	44.314



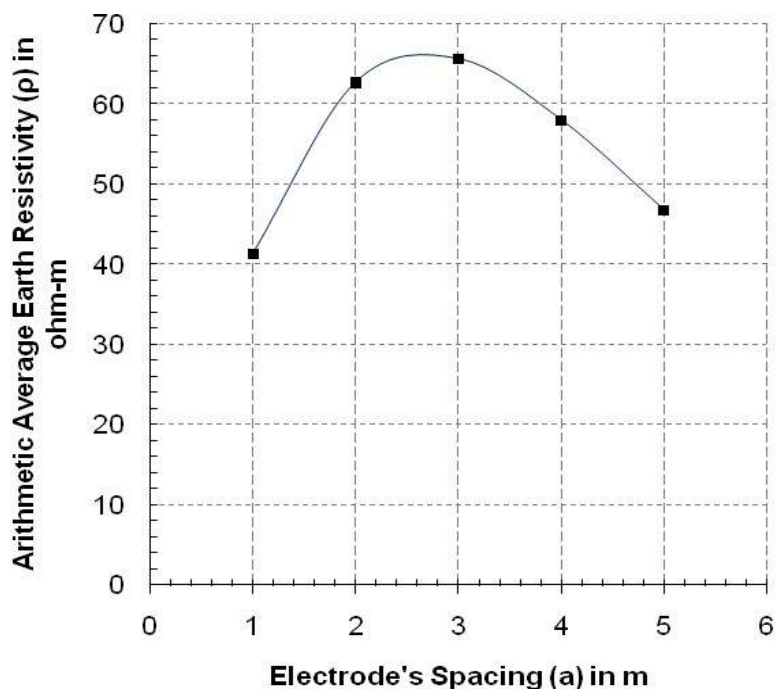
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PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
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ERT – 07

Co-ordinate: E 593485.00, N 754810.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N-S	E-W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	42.240	40.543	41.391
2	2	62.480	63.109	62.794
3	3	66.189	65.246	65.717
4	4	59.840	56.320	58.080
5	5	47.457	46.200	46.829



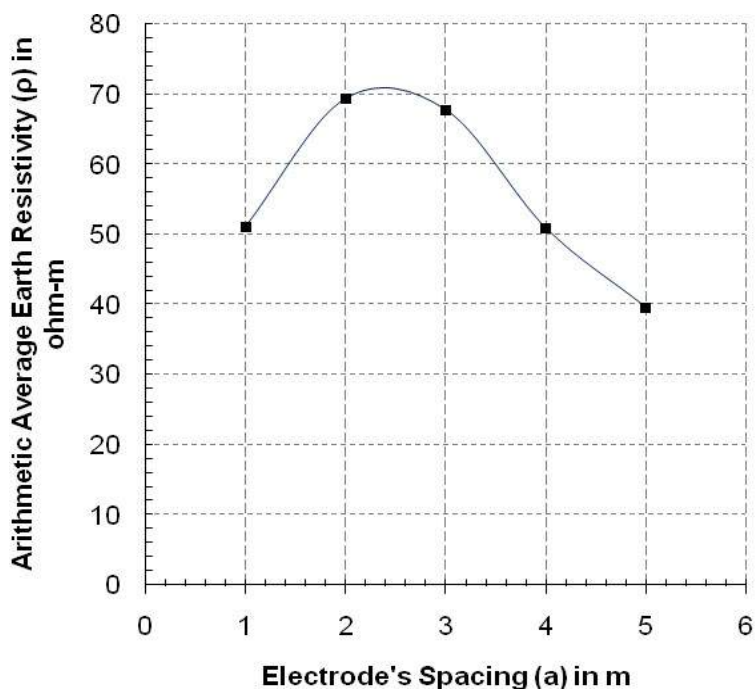
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PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
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ERT – 08

Co-ordinate: E 593560.00, N 754830.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N-S	E-W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	52.234	50.034	51.134
2	2	73.291	65.497	69.394
3	3	67.697	67.886	67.791
4	4	51.543	50.286	50.914
5	5	37.086	42.114	39.600



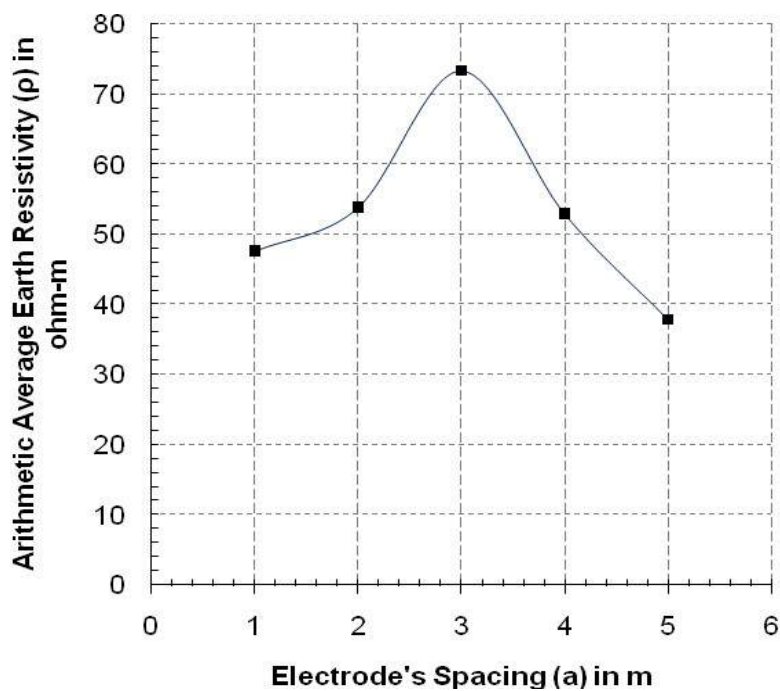
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PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

ERT – 09

Co-ordinate: E 593485.00, N 754830.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N-S	E-W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	48.023	47.269	47.646
2	2	54.686	53.051	53.869
3	3	72.789	73.920	73.354
4	4	53.554	52.297	52.926
5	5	37.400	38.343	37.871



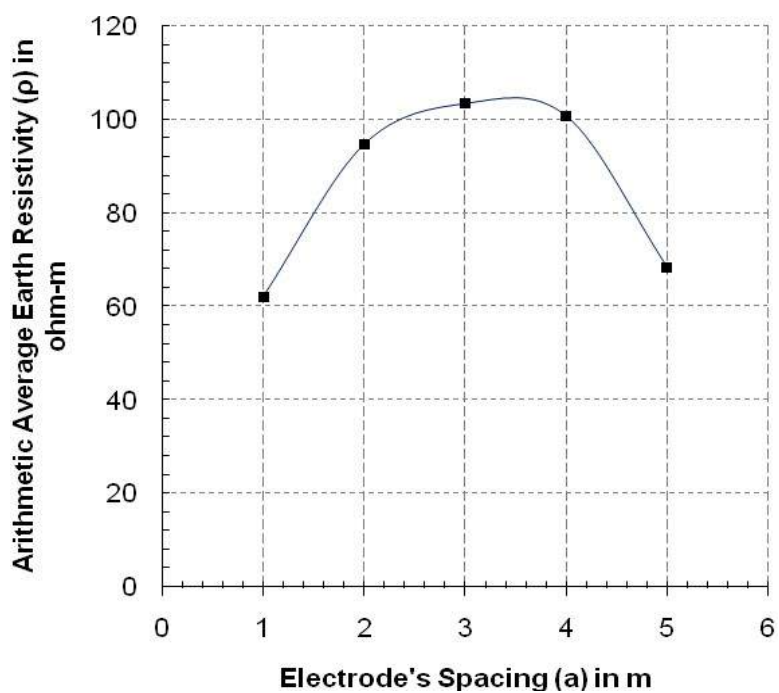
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CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
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ERT – 10

Co-ordinate: E 593600.00, N 754865.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N-S	E-W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	63.297	60.846	62.071
2	2	95.405	93.909	94.657
3	3	100.320	106.354	103.337
4	4	100.320	101.074	100.697
5	5	66.943	69.771	68.357



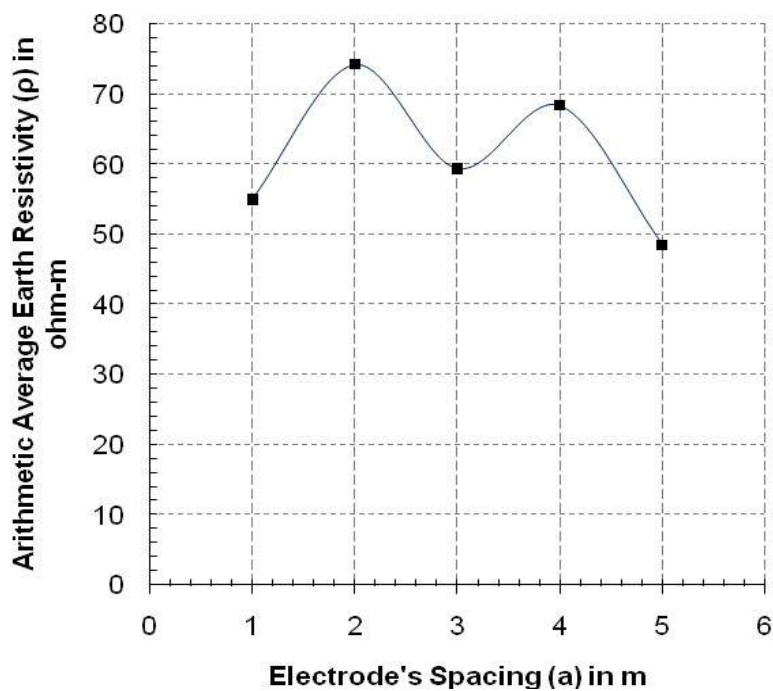
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PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

ERT – 11

Co-ordinate: E 593470.00, N 754870.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N-S	E-W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	55.629	54.434	55.031
2	2	72.789	75.680	74.234
3	3	57.703	61.097	59.400
4	4	67.634	69.143	68.389
5	5	46.829	50.286	48.557



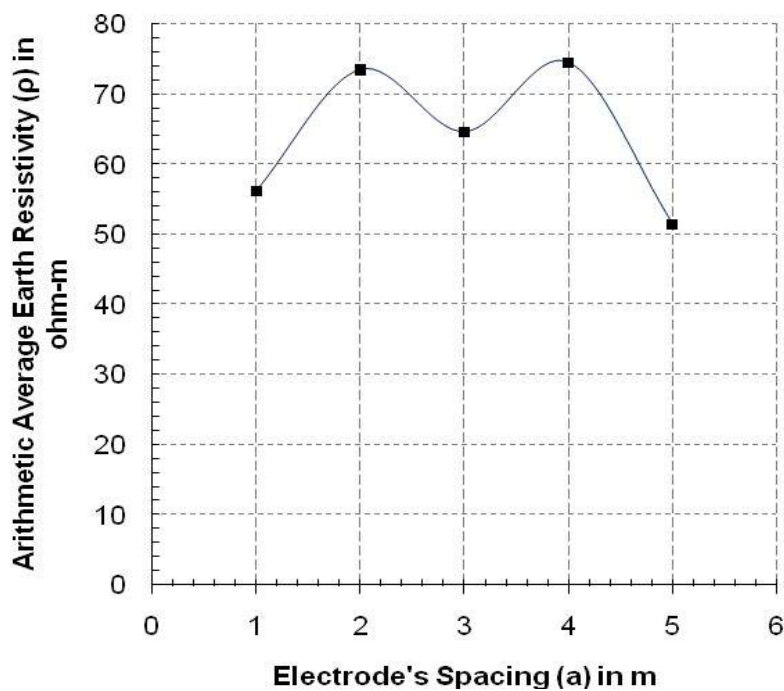
**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

ERT – 12

Co-ordinate: E 593570.00, N 754910.00

Sl. no.	Electrode Spacing	Apparent soil resistivity		Apparent soil resistivity
	(a)	Direction	Direction	(Arithmetic average)
		N-S	E-W	$\rho(\text{avg.})$
		$\rho(N-S)$	$\rho(E-W)$	
	m	ohm-m	ohm-m	ohm-m
1	1	55.754	56.697	56.226
2	2	74.423	72.663	73.543
3	3	59.966	69.394	64.680
4	4	72.411	76.686	74.549
5	5	48.086	55.000	51.543



**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

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6.0 Discussion

The results indicate that resistivity values vary across vertically and horizontally, though a generally consistent pattern is observed at each test location. At the 1m spacing, the resistivity values are the lowest, typically ranging from around 35 to 60 Ohm-m. At spacing of 2, 3, and 4 m, the resistivity values increase slightly, generally falling approximately between 50 and 80 Ohm-m. At 5 m, the resistivity values decrease again to around 40 to 60 Ohm-m. However, in most cases, the resistivity at 5 m remains higher than that at the 1m spacing.



GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
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7.0 Field Photographs





GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
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PROJECT	108 MW Gas Based Power Plant
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DATE	September, 2025



PART – 3

REPORT ON PERMEABILITY TEST

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
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Report on

Permeability Test for 108 MW Gas based Power Plant at Great Nicobar Island, India

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3.0 Discussion	3
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**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
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1.0 Field Permeability Test

Field Permeability test has been conducted at site. Permeability test using falling head method has been deployed. Falling head permeability as per IS 5529 (Part – I) : 2013 has been conducted at site.

The coefficient of permeability (k) is calculated using the formula:

$$K = \frac{d^2}{8L} \left(\log_e \frac{L}{R} \right) \frac{\log_e h_1 / h_2}{t_2 - t_1} \dots\dots\dots (i)$$

Where:

- K = coefficient of permeability (cm/sec),
- d = diameter of intake pipe (stand pipe),
- R = Radius of hole,
- L = length of the test section (cm),
- t₁ and t₂ = time interval between h₁ and h₂ (sec),
- h₁ and h₂ = initial and final heads (cm).

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

2.0 RESULTS

The results of permeability test is mentioned below:-

BH No.	Test Section	Stratum Description	Co-efficient of Permeability (K) (cm/sec)
05	2.00 m to 7.00 m	Silty fine sand	1.05×10^{-5}
08	1.00 m to 5.20 m	Silty fine sand	8.08×10^{-6}
08	8.00 m to 14.50 m	Decomposed sedimentary rock	8.91×10^{-6}
10	3.00 m to 9.00 m	Decomposed sedimentary rock	5.53×10^{-6}
10	10.50 m to 18.00 m	Decomposed sedimentary rock	4.78×10^{-6}
11	5.00 m to 11.00 m	Decomposed sedimentary rock	6.75×10^{-6}
11	13.00 m to 20.00 m	Silty fine sand	6.90×10^{-6}
12	2.00 m to 6.50 m	Decomposed sedimentary rock	8.25×10^{-6}
12	9.50 m to 17.00 m	Silty fine sand	6.38×10^{-6}
13	2.00 m to 7.00 m	Silty fine sand	1.05×10^{-5}
13	9.00 m to 16.50 m	Decomposed sedimentary rock	6.98×10^{-6}
15	3.50 m to 9.00 m	Decomposed sedimentary rock	1.28×10^{-5}
15	12.00 m to 19.50 m	Decomposed sedimentary rock	9.50×10^{-6}
16	5.00 m to 11.50 m	Silty fine sand	6.17×10^{-6}
16	13.00 m to 20.50 m	Decomposed sedimentary rock	5.25×10^{-6}
21	6.00 m to 10.00 m	Silty fine sand	1.20×10^{-5}
21	11.50 m to 18.00 m	Decomposed sedimentary rock	6.29×10^{-6}
24	2.00 m to 9.50 m	Silty fine sand	4.68×10^{-6}
24	11.00 m to 18.00 m	Decomposed sedimentary rock	5.29×10^{-6}
25	7.00 m to 14.50 m	Decomposed sedimentary rock	4.78×10^{-6}

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

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3.0 DISCUSSION

The single packer permeability tests conducted using the falling head method revealed that the subsurface strata possess low to moderate permeability, with calculated coefficients of permeability ranging between 1.05×10^{-5} to 9.50×10^{-6} cm/sec. These values are typical for decomposed rock and silty sand layers encountered below the groundwater table.

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ANNEXURE – I**SAMPLE COMPUTATION (as per IS 5529 (part 1) : 2013) for BH – 11**

Test Section : 13.00 m to 20.00 m = 7.00 m = 700 cm

Depth of water table : 0.30 m below EGL

So, $L = 700$ cm, $d = (3)^2 = 9$ cm², $R = 3.81$ cm, $h_0 = 130$ cm,

$L/R = 700/3.81 = 183.73$, $\log_e (L/R) = \log_e 183.73 = 5.21$,

$h_1/h_0 = 0.39$ $t_1 = 20$ min (from Fig.01 given below)

$h_2/h_0 = 0.20$ $t_2 = 33.50$ min (from Fig.01 given below)

and $h_1/h_2 = 1.95$ $t_2 - t_1 = 13.50$ min

Substituting the values in equation (i),

$= [9/(8 \times 700)] \times 5.21 \cdot (\log_e 1.95)/13.50$ cm/min

$= 6.896 \times 10^{-6}$ cm/sec

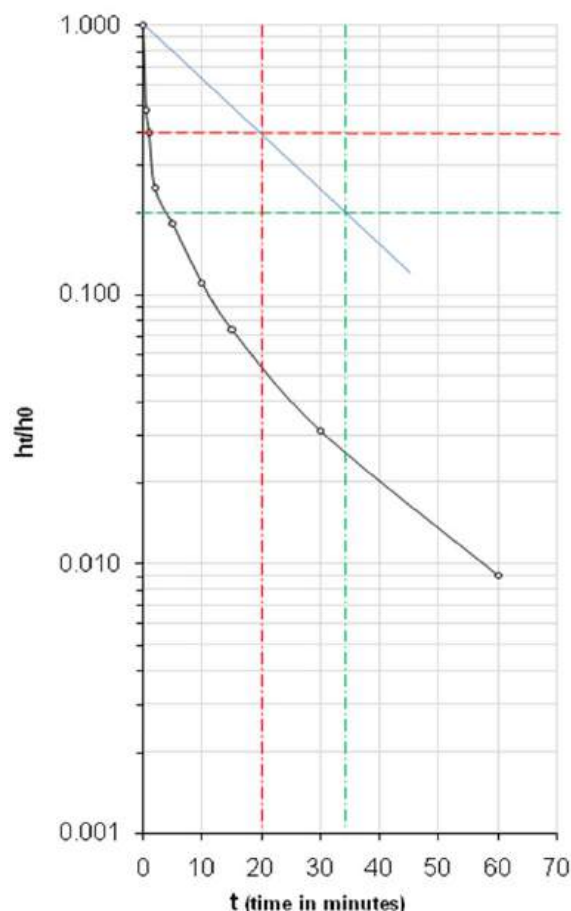


Fig. 01 Semi-Log Plot of Head Ratio Versus Time of Test (Falling Head Method)



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ANNEXURE – II

FIELD WORK PHOTOGRAPHS



PART -4

SUB-SOIL REPORT ON SUB-STATION

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

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Report on

Sub-soil Investigation on Sub-Stations for 108 MW Gas based Power Plant at Great Nicobar Island, India

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1.2 Susceptibility of Subsoil to Liquifaction	

Annexures

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SPT Correction	Annexure – II
Laboratory Test Results	Annexure – III
Field Photographs	Annexure – IV

FIGURES

Sub- soil Profile	Fig.1
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**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

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1.0 SUB-SOIL INVESTIGATION RESULT ON SUB-STATIONS**1.1 Sub-Soil Profile**

Depending on field observation and laboratory test results the sub-soil deposits of the four numbers borehole of three different substations are classified into different strata. The borehole data indicate more or less similar sub-soil stratification. Altogether five strata have been identified. Stratum wise description has been presented below.

Stratum I – Clayey silt with decomposed wood

This stratum consists of bluish grey to grey, wet, soft to stiff, clayey silt with organic soil & decomposed wood, sometimes mixed with sea shale. This stratum has been significantly encountered in 1 out of 4 boreholes.

Stratum II – Sandy silt

This stratum consists of bluish grey to grey, moist, loose to medium dense, sandy silt. This stratum has been significantly encountered in 2 out of 4 boreholes.

Stratum III – Silty sand

This stratum consists of bluish grey to grey, wet, loose to medium dense, silty fine sand. This stratum has been significantly encountered in 2 out of 4 boreholes.

Stratum IIIA – Silty sand

This stratum consists of bluish grey to grey, wet, medium dense to dense, silty fine sand. This stratum has been significantly encountered in 1 out of 4 boreholes.

Stratum IVA – Decomposed sedimentary rock

This stratum consists of blackish grey, wet, dense to very dense, silty fine sand. This layer has been termed as decomposed sedimentary rock material. This layer is behaves as sandy horizon. This stratum has been encountered in 1 out of 4 boreholes.

Stratum IVB – Decomposed sedimentary rock

This stratum consists of blackish grey, moist, hard, decomposed sedimentary rock. This layer has been termed as decomposed sedimentary rock material. This layer is behaves as clayey horizon. This stratum has been encountered in 2 out of 4 boreholes. This stratum is found in Gandhi Nagar sub-station.

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1.2 Susceptibility of Subsoil to Liquefaction

The present site is under seismic zone – V. The liquefaction potential of subsoil is evaluated as per provision laid down in Indian Standard **[IS: 1893 (Part – 1) 2016]** and *“Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils” by Dr. Gonzalo Castro et al. published in “Journal of Geotechnical and Geo-environmental Engineering”, October’ 2001.* Based on the SPT values, the liquefaction resistance of the borehole was evaluated for zone – V as per IS: 1893 Part – I and presented below. The ratio of $CRR/CSR \leq 1.0$ indicates that the soil is prone to liquefaction whereas $CRR/CSR > 1.0$ or corrected $N1 > 30$ indicates the soil is non liquefiable. Based on the above, the liquefaction resistance of the subsoil is determined and presented below. As per H. B. Seed and I.M. Idriss (1982) a clayey soil is said to be non-liquefiable if any one of the following three criteria is satisfied.

- a) the soil contains fine grained soils with clay contents greater than 15%,
- b) liquid limit greater than 35% or
- c) Moisture contents less than 90% of the liquid limit.

In the present case, Stratum-I, startum - II is having liquid limit greater than 35%. So this layer is non-liquefiable.



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Zone: V			a_{max}/g	0.36	Earthquake magnitude =				7.50					Bulk density =			1.94			
BH No.	Depth (m)	Field N	Total OVP (t/sqm)	Effective OVP (t/sqm)	C_N	C_{HT}	C_{HW}	C_{BD}	C_{ss}	C_{RD}	$(N_1)_{90}$	FC	α	β	$(N_1)_{90CS}$	r_d	CSR	$CRR_{7.5}$	FOS _{7.5}	REMARKS
Sub Station, Cambell Bay BH - 1	1.50	2	2.91	1.41	clayey silt															Non Liquefiable
	3.00	3	5.82	2.82																Non Liquefiable
	4.50	5	8.75	4.25																Non Liquefiable
	6.00	7	11.67	5.67																Non Liquefiable
	7.50	13	14.60	7.10																Non Liquefiable
	9.00	14	17.52	8.52																Non Liquefiable
	10.50	18	20.45	9.95																Non Liquefiable
	12.00	22	23.37	11.37																Non Liquefiable
	13.50	26	26.30	12.80																Non Liquefiable
	15.00	32	29.22	14.22																Non Liquefiable
	16.50	34	32.15	15.65																Non Liquefiable
	18.00	27	35.07	17.07																Non Liquefiable
	19.50	33	38.00	18.50																Non Liquefiable
	21.00	47	40.92	19.92																Non Liquefiable
	22.50	52	43.85	21.35																Non Liquefiable
	24.00	47	46.77	22.77																Non Liquefiable
	25.50	50	49.70	24.20																Non Liquefiable

Zone: V			a_{max}/g	0.36	Earthquake magnitude =					7.50					Bulk density =			1.90			
BH No.	Depth (m)	Field N	Total OVP (t/sqm)	Effective OVP (t/sqm)	C_N	C_{HT}	C_{HW}	C_{BD}	C_{ss}	C_{RD}	$(N_1)_{90}$	FC	α	β	$(N_1)_{90CS}$	r_d	CSR	$CRR_{7.5}$	FOS7.5	REMARKS	
Sub Station Vijay Nagar, BH 01	1.50	12			Sandy Silt																Non Liquefiable
	3.00	19																			Non Liquefiable
	4.50	18																			Non Liquefiable
	6.00	27																			Non Liquefiable
	7.50	28	13.88	0.38	1.23	0.75	0.98	1.05	1.10	0.95	28.0	17	3.01	1.00	32.7	0.94	0.48	0.99	2.00	Non Liquefiable	
	9.00	34	16.65	7.65	1.14	0.75	0.98	1.05	1.20	0.95	34.3	17	3.01	1.06	39.3	0.93	0.47	0.10	0.21	Non Liquefiable	
	10.50	37	19.43	8.93	1.06	0.75	0.98	1.05	1.20	1.00	36.4	17	3.01	1.06	41.6	0.89	0.46	0.17	0.37	Non Liquefiable	
	12.00	100	22.20	10.20	0.98	0.75	0.98	1.05	1.20	1.00	91.3	17	3.01	1.06	99.8	0.85	0.43	0.72	1.65	Non Liquefiable	
	13.50	100	24.98	11.48	0.91	0.75	0.98	1.05	1.20	1.00	85.1	16	2.77	1.05	92.4	0.81	0.41	0.66	1.60	Non Liquefiable	
	15.00	100	27.75	12.75	0.86	0.75	0.98	1.05	1.20	1.00	79.6	16	2.77	1.05	86.7	0.77	0.39	0.82	1.57	Non Liquefiable	
	16.50	100	30.53	14.03	0.80	0.75	0.98	1.05	1.20	1.00	74.8	16	2.77	1.05	81.7	0.73	0.37	0.58	1.55	Non Liquefiable	
	18.00	100	33.30	15.30	0.76	0.75	0.98	1.05	1.20	1.00	70.7	16	2.77	1.05	77.3	0.69	0.35	0.54	1.54	Non Liquefiable	
	19.50	100	36.08	16.58	0.72	0.75	0.98	1.05	1.20	1.00	67.2	16	2.77	1.05	73.6	0.65	0.33	0.51	1.55	Non Liquefiable	
	21.00	100	38.85	17.85	0.69	0.75	0.98	1.05	1.20	1.00	64.2	16	2.77	1.05	70.4	0.61	0.31	0.49	1.57	Non Liquefiable	
	22.50	100	41.03	19.13	0.60	0.75	0.98	1.05	1.20	1.00	61.7	16	2.77	1.05	67.8	0.57	0.29	0.47	1.60	Non Liquefiable	
	24.00	100	44.40	20.40	0.64	0.75	0.98	1.05	1.20	1.00	59.6	16	2.77	1.05	65.6	0.53	0.27	0.45	1.66	Non Liquefiable	
	25.50	100	47.18	21.68	0.62	0.75	0.98	1.05	1.20	1.00	58.0	16	2.77	1.05	63.9	0.49	0.25	0.44	1.73	Non Liquefiable	

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Zone: V			a_{max}/g	0.36	Earthquake magnitude = 7.50										Bulk density = 1.85						
BH No.	Depth (m)	Field N	Total OVP (t/sqm)	Effective OVP (t/sqm)	C_N	C_{HT}	C_{HW}	C_{BD}	C_{SS}	C_{RD}	$(N_1)_{90}$	FC	α	β	$(N_1)_{90CS}$	r_d	CSR	$CRR_{7.5}$	FOS _{7.5}	REMARKS	
Substation Gandhi Nagar, BH-1	1.50	6																		Non Liquefiable	
	3.00	7																		Non Liquefiable	
	4.50	10																		Non Liquefiable	
	6.00	20																		Non Liquefiable	
	7.50	61	13.04	6.14	1.25	0.75	0.98	1.05	1.20	0.95	67.5	24	4.18	1.11	78.9	0.94	0.47	0.56	1.19	Non Liquefiable	
	9.00	100	15.82	7.42	1.16	0.75	0.98	1.05	1.20	0.95	102.2	16	2.77	1.05	110.5	0.93	0.46	0.80	1.72	Non Liquefiable	
	10.50	100	18.59	8.69	1.07	0.75	0.98	1.05	1.20	1.00	99.6	16	2.77	1.05	107.8	0.89	0.45	0.78	1.74	Non Liquefiable	
	12.00	100	21.37	9.97	0.99	0.75	0.98	1.05	1.20	1.00	92.5	16	2.77	1.05	100.3	0.85	0.43	0.72	1.60	Non Liquefiable	
	13.50	100	24.14	11.24	0.93	0.75	0.98	1.05	1.20	1.00	86.2	16	2.77	1.05	93.6	0.81	0.41	0.67	1.64	Non Liquefiable	
	15.00	100	26.92	12.52	0.87	0.75	0.98	1.05	1.20	1.00	80.6	16	2.77	1.05	87.7	0.77	0.39	0.63	1.61	Non Liquefiable	
	16.50	100	29.69	13.79	0.81	0.75	0.98	1.05	1.20	1.00	75.7	16	2.77	1.05	82.5	0.73	0.37	0.59	1.59	Non Liquefiable	
	18.00	100	32.47	15.07	0.77	0.75	0.98	1.05	1.20	1.00	71.4	16	2.77	1.05	78.0	0.69	0.35	0.55	1.57	Non Liquefiable	
	19.50	100	35.24	16.34	0.73	0.75	0.98	1.05	1.20	1.00	67.8	16	2.77	1.05	74.2	0.65	0.33	0.52	1.58	Non Liquefiable	
	21.00	100	38.02	17.62	0.70	0.75	0.98	1.05	1.20	1.00	64.7	16	2.77	1.05	70.9	0.61	0.31	0.49	1.59	Non Liquefiable	
	22.50	100	40.79	18.89	0.67	0.75	0.98	1.05	1.20	1.00	62.1	16	2.77	1.05	68.2	0.57	0.29	0.47	1.63	Non Liquefiable	
	24.00	100	43.57	20.17	0.64	0.75	0.98	1.05	1.20	1.00	60.0	16	2.77	1.05	66.0	0.53	0.27	0.45	1.68	Non Liquefiable	
	25.50	100	46.34	21.44	0.63	0.75	0.98	1.05	1.20	1.00	58.3	16	2.77	1.05	64.2	0.49	0.25	0.44	1.75	Non Liquefiable	

Zone: V			a_{max}/g	0.36	Earthquake magnitude = 7.50										Bulk density = 1.85						
BH No.	Depth (m)	Field N	Total OVP (t/sqm)	Effective OVP (t/sqm)	C_N	C_{HT}	C_{HW}	C_{BD}	C_{SS}	C_{RD}	$(N_1)_{90}$	FC	α	β	$(N_1)_{90CS}$	I_d	CSR	$CRR_{7.5}$	FOS _{7.5}	REMARKS	
Substation Gandhi Nagar, BH - 02	1.50	7	1.46	0.66	1.78	0.75	0.98	1.05	1.10	0.75	8.0	21	3.78	1.09	12.4	0.99	0.51	0.14	0.27	Liquefiable	
	3.00	10	4.22	1.92	1.64	0.75	0.98	1.05	1.10	0.80	11.2	21	3.78	1.09	15.9	0.98	0.50	0.17	0.34	Liquefiable	
	4.50	13	6.98	3.16	1.51	0.75	0.98	1.05	1.10	0.85	14.2	21	3.78	1.09	19.2	0.97	0.50	0.21	0.42	Liquefiable	
	6.00	30	9.76	4.46	1.39	0.75	0.98	1.05	1.10	0.95	33.8	21	3.78	1.09	40.5	0.95	0.49	0.14	0.29	Non Liquefiable	
	7.50	50	12.56	5.76	1.28	0.75	0.98	1.05	1.20	0.95	56.6	16	2.77	1.05	62.4	0.94	0.48	0.42	0.88	Non Liquefiable	
	9.00	100	15.41	7.11	1.18	0.75	0.98	1.05	1.20	0.95	104.1	99	0.50	1.20	125.4	0.93	0.47	0.91	1.93	Non Liquefiable	
	10.50	100	18.26	8.46	1.09	0.75	0.98	1.05	1.20	1.00	101.0	95	0.50	1.20	121.7	0.89	0.45	0.88	1.96	Non Liquefiable	
	12.00	100	21.11	9.81	1.00	0.75	0.98	1.05	1.20	1.00	93.3	90	0.50	1.20	112.5	0.85	0.43	0.82	1.90	Non Liquefiable	
	13.50	100	23.96	11.16	0.93	0.75	0.98	1.05	1.20	1.00	86.5	90	0.50	1.20	104.3	0.81	0.41	0.75	1.84	Non Liquefiable	
	15.00	100	26.81	12.51	0.87	0.75	0.98	1.05	1.20	1.00	80.6	90	0.50	1.20	97.2	0.77	0.39	0.70	1.80	Non Liquefiable	
	16.50	100	29.66	13.86	0.81	0.75	0.98	1.05	1.20	1.00	75.4	90	0.50	1.20	91.0	0.73	0.37	0.65	1.77	Non Liquefiable	
	18.00	100	32.51	15.21	0.76	0.75	0.98	1.05	1.20	1.00	71.0	90	0.50	1.20	85.7	0.69	0.35	0.61	1.76	Non Liquefiable	
	19.50	100	35.36	16.56	0.72	0.75	0.98	1.05	1.20	1.00	67.2	90	0.50	1.20	81.1	0.65	0.33	0.57	1.76	Non Liquefiable	
	21.00	100	38.21	17.91	0.69	0.75	0.98	1.05	1.20	1.00	64.0	90	0.50	1.20	77.3	0.61	0.31	0.54	1.78	Non Liquefiable	
	22.50	100	41.06	19.26	0.66	0.75	0.98	1.05	1.20	1.00	61.4	90	0.50	1.20	74.2	0.57	0.29	0.52	1.82	Non Liquefiable	
	24.00	100	43.91	20.61	0.64	0.75	0.98	1.05	1.20	1.00	59.3	90	0.50	1.20	71.7	0.53	0.27	0.50	1.88	Non Liquefiable	
	25.50	100	46.76	21.96	0.62	0.75	0.98	1.05	1.20	1.00	57.7	90	0.50	1.20	69.7	0.49	0.25	0.48	1.97	Non Liquefiable	

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Recommended Allowable bearing capacity values are as follows:

Location	Foundation Width (m)	Depth of Foundation below EGL (m)	Net Ultimate Bearing Capacity (t/m^2)	Net Safe Bearing Capacity (t/m^2)	Anticipated Settlement (mm)	Allowable Bearing Capacity for 25 mm settlement (t/m^2)	Allowable Bearing Capacity for 40 mm settlement (t/m^2)	Allowable Bearing Capacity for 75 mm settlement (t/m^2)
Substation Cambell Bay, BH – 1	1.00 – 3.00	2.00	9.17	3.06	50.16	1.50	2.00	---
	3.00 – 6.00		9.05	3.02	65.55	1.00	1.50	---
	>6.00		8.64	2.88	71.29	---	---	2.50
	1.00 – 3.00	3.00	9.71	3.24	43.94	1.50	2.50	---
	3.00 – 6.00		8.91	2.97	68.08	1.00	1.50	---
	>6.00		8.70	2.90	62.91	---	---	2.50
	1.00 – 3.00	4.00	10.25	3.42	40.14	1.50	3.00	---
	3.00 – 6.00		9.17	3.06	60.13	1.00	2.00	---
	>6.00		8.91	2.97	55.63	---	---	2.50

Location	Foundation Width (m)	Depth of Foundation below EGL (m)	Net Ultimate Bearing Capacity (t/m^2)	Net Safe Bearing Capacity (t/m^2)	Anticipated Settlement (mm)	Allowable Bearing Capacity for 25 mm settlement (t/m^2)	Allowable Bearing Capacity for 40 mm settlement (t/m^2)	Allowable Bearing Capacity for 75 mm settlement (t/m^2)
Substation Vijay Nagar, BH – 1	1.00 – 3.00	2.00	30.85	10.28	14.80	10.00	10.00	---
	3.00 – 6.00		35.11	11.70	19.89	11.50	11.50	---
	>6.00		47.99	16.00	30.40	---	---	15.00
	1.00 – 3.00	3.00	48.03	15.93	22.94	14.00	14.00	---
	3.00 – 6.00		47.87	16.08	25.73	14.00	15.00	---
	>6.00		59.49	19.83	35.69	---	---	18.00
	1.00 – 3.00	4.00	93.66	31.22	33.72	20.00	25.00	---
	3.00 – 6.00		86.14	28.71	41.34	16.00	25.00	---
	>6.00		100.00	33.33	45.33	---	---	26.00

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Location	Foundation Width (m)	Depth of Foundation below EGL (m)	Net Ultimate Bearing Capacity (t/m^2)	Net Safe Bearing Capacity (t/m^2)	Anticipated Settlement (mm)	Allowable Bearing Capacity for 25 mm settlement (t/m^2)	Allowable Bearing Capacity for 40 mm settlement (t/m^2)	Allowable Bearing Capacity for 75 mm settlement (t/m^2)
Substation Gandhi Nagar, BH – 1	1.00 – 3.00	2.00	30.85	10.28	14.80	10.00	10.00	---
	3.00 – 6.00		35.11	11.70	19.89	11.50	11.50	---
	>6.00		47.99	16.00	30.40	---	---	15.00
	1.00 – 3.00	3.00	48.03	15.93	22.94	14.00	14.00	---
	3.00 – 6.00		47.87	16.08	25.73	14.00	15.00	---
	>6.00		59.49	19.83	35.69	---	---	18.00
	1.00 – 3.00	4.00	68.47	22.82	32.86	14.50	18.00	---
	3.00 – 6.00		61.93	20.64	29.72	16.00	20.00	---
	>6.00		71.49	23.83	40.51	---	---	22.00
Substation Gandhi Nagar, BH – 2	1.00 – 3.00	2.00	18.14	6.05	19.36	6.00	6.00	---
	3.00 – 6.00		20.95	6.98	23.73	6.50	6.50	---
	>6.00		47.99	16.00	30.40	---	---	15.00
	1.00 – 3.00	3.00	28.18	9.39	27.04	8.00	9.00	---
	3.00 – 6.00		28.99	9.66	28.98	8.00	9.50	---
	>6.00		59.49	19.83	35.69	---	---	18.00
	1.00 – 3.00	4.00	68.47	22.82	32.86	14.50	18.00	---
	3.00 – 6.00		61.93	20.64	29.72	16.00	20.00	---
	>6.00		71.49	23.83	40.51	---	---	22.00

*Note: The data provided in the above table is borehole specific.

Rev. 01**Sub-Station Report**

Annexure I
Borehole Log

Borehole No. BH-01
Location Substation Campbell Bay

Borehole Depth 25.00 m
Water Table 0.50 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m.)	Recovery (%)	RQD (%)			Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Bluish grey to grey, wet, soft to medium stiff, clayey silt mixed with organic soil and decomposed wood.	Little	Grey
2	0.50-1.00	DS	---	---	---	---				
3	1.00-1.40	UDS	---	---	---	---				
4	1.50-1.95	SPT	1,1,1 (2)	---	---	---				
5	2.00-2.50	DS	---	---	---	---				
6	2.50-3.00	DS	---	---	---	---				
7	3.00-3.45	SPT	1,1,2 (3)	---	---	---				
8	3.50-4.00	DS	---	---	---	---				
9	4.00-4.40	UDS	---	---	---	---				
10	4.50-4.95	SPT	2,2,3 (5)	---	---	---				
11	5.00-5.50	DS	---	---	---	---				
12	5.50-6.00	DS	---	---	---	---				
13	6.00-6.45	SPT	2,3,4 (7)	---	---	---				
14	6.50-7.00	DS	---	---	---	---				
15	7.00-7.50	DS	---	---	---	---				
16	7.50-7.95	SPT	3,5,8 (13)	---	---	---	7.50	Bluish grey to blackish grey, wet, medium stiff to stiff, clayey silt mixed with sea shale, organic soil and decomposed wood.		
17	8.00-8.50	DS	---	---	---	---				
18	8.50-9.00	DS	---	---	---	---				
19	9.00-9.45	SPT	5,5,9 (14)	---	---	---				
20	9.50-10.00	DS	---	---	---	---				
21	10.00-10.50	DS	---	---	---	---				
22	10.50-10.95	SPT	6,8,10 (18)	---	---	---				
23	11.00-11.50	DS	---	---	---	---				
24	11.50-12.00	DS	---	---	---	---				
25	12.00-12.45	SPT	6,10,12 (22)	---	---	---				
26	12.50-13.00	DS	---	---	---	---				
27	13.00-13.50	DS	---	---	---	---				
28	13.50-13.95	SPT	7,11,15 (26)	---	---	---				

DS = Disturbed Sample, SPT = Standard Penetration Test, UDS = Undisturbed Sample, ® = Refusal.

Annexure I
Borehole Log

Borehole No. BH-01
Location Substation, Campbell Bay

Borehole Depth 25.00 m
Water Table 0.50 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m.)	Recovery (%)	RQD (%)			Water loss	Colour
29	14.00-14.50	DS	---	---	---	---	25.00	Bluish grey to blackish grey, wet, medium stiff to stiff, clayey silt mixed with sea shale, organic soil and decomposed wood.	Little	Grey
30	14.50-15.00	DS	---	---	---	---				
31	15.00-15.45	SPT	8,14,18 (32)	---	---	---				
32	15.50-16.00	DS	---	---	---	---				
33	16.00-16.50	DS	---	---	---	---				
34	16.50-16.95	SPT	10,15,19 (34)	---	---	---				
35	17.00-17.50	DS	---	---	---	---				
36	17.50-18.00	DS	---	---	---	---				
37	18.00-18.45	SPT	10,12,15 (27)	---	---	---				
38	18.50-19.00	DS	---	---	---	---				
39	19.00-19.50	DS	---	---	---	---				
40	19.50-19.95	SPT	10,15,18 (33)	---	---	---				
41	20.00-20.50	DS	---	---	---	---				
42	20.50-21.00	DS	---	---	---	---				
43	21.00-21.45	SPT	11,18,29 (47)	---	---	---				
44	21.50-22.00	DS	---	---	---	---				
45	22.00-22.50	DS	---	---	---	---				
46	22.50-22.95	SPT	11,20,32 (52)	---	---	---				
47	23.00-23.50	DS	---	---	---	---				
48	23.50-24.00	DS	---	---	---	---				
49	24.00-24.45	SPT	18,22,25 (47)	---	---	---				
50	24.50-25.00	DS	---	---	---	---				
51	25.00-25.45	SPT	20,22,28 (50)	---	---	---				

DS = Disturbed Sample, SPT = Standard Penetration Test, UDS = Undisturbed Sample, ® = Refusal.

Annexure I
Borehole Log

Borehole No. BH-01
Location Substation, Vijaynagar

Borehole Depth 25.00 m
Water Table 0.80 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m.)	Recovery (%)	RQD (%)			Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Bluish grey to grey, wet, medium stiff to stiff, sandy silt mixed with clay.	Little	Grey
2	0.50-1.00	DS	---	---	---	---				
3	1.00-1.40	UDS	(slipped)	---	---	---				
4	1.50-1.95	SPT	3,5,7 (12)	---	---	---				
5	2.00-2.50	DS	---	---	---	---				
6	2.50-3.00	DS	---	---	---	---				
7	3.00-3.45	SPT	4,7,12 (19)	---	---	---				
8	3.50-4.00	DS	---	---	---	---				
9	4.00-4.50	DS	---	---	---	---				
10	4.50-4.95	SPT	5,7,11 (18)	---	---	---				
11	5.00-5.50	DS	---	---	---	---				
12	5.50-6.00	DS	---	---	---	---				
13	6.00-6.45	SPT	8,12,15 (27)	---	---	---				
14	6.50-7.00	DS	---	---	---	---				
15	7.00-7.50	DS	---	---	---	---				
16	7.50-7.95	SPT	8,13,15 (28)	---	---	---	7.50			
17	8.00-8.50	DS	---	---	---	---	Blackish grey, wet, medium dense to dense, silty fine sand (decomposed sedimentary rock).			
18	8.50-9.00	DS	---	---	---	---				
19	9.00-9.38	SPT	11,15,19 (34)	---	---	---				
20	9.50-10.00	DS	---	---	---	---				
21	10.00-10.50	DS	---	---	---	---				
22	10.50-10.75	SPT	15,16,21 (37)	---	---	---				
23	11.00-11.50	DS	---	---	---	---				
24	11.50-12.00	DS	---	---	---	---				
25	12.00-12.38	SPT	19,38,57 blows / 8 cm ®	---	---	---		12.00		
26	12.38-13.00	DS	---	---	---	---	Blackish grey, wet, dense, silty fine sand (decomposed sedimentary rock).			
27	13.00-13.50	DS	---	---	---	---				
28	13.50-13.70	SPT	28,54 blows / 5 cm ®	---	---	---				

DS = Disturbed Sample, SPT = Standard Penetration Test, UDS = Undisturbed Sample, ® = Refusal.

Annexure I
Borehole Log

Borehole No. BH-01
Location Substation, Vijaynagar

Borehole Depth 25.00 m
Water Table 0.50 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m.)	Recovery (%)	RQD (%)			Water loss	Colour
29	14.00-14.50	DS	---	---	---	---	25.00	Blackish grey, wet, dense, silty fine sand (decomposed sedimentary rock).	Little	Grey
30	14.50-15.00	DS	---	---	---	---				
31	15.00-15.14	SPT	56 blows / 14 cm ®	---	---	---				
32	15.50-16.00	DS	---	---	---	---				
33	16.00-16.50	DS	---	---	---	---				
34	16.50-16.61	SPT	58 blows / 11 cm ®	---	---	---				
35	17.00-17.50	DS	---	---	---	---				
36	17.50-18.00	DS	---	---	---	---				
37	18.00-18.09	SPT	57 blows / 9 cm ®	---	---	---				
38	18.50-19.00	DS	---	---	---	---				
39	19.00-19.50	DS	---	---	---	---				
40	19.50-19.64	SPT	56 blows / 14 cm ®	---	---	---				
41	20.00-20.50	DS	---	---	---	---				
42	20.50-21.00	DS	---	---	---	---				
43	21.00-21.12	SPT	60 blows / 12 cm ®	---	---	---				
44	21.50-22.00	DS	---	---	---	---				
45	22.00-22.50	DS	---	---	---	---				
46	22.50-22.63	SPT	55 blows / 13 cm ®	---	---	---				
47	23.00-23.50	DS	---	---	---	---				
48	23.50-24.00	DS	---	---	---	---				
49	24.00-24.10	SPT	54 blows / 10 cm ®	---	---	---				
50	24.50-25.00	DS	---	---	---	---				
51	25.00-25.13	SPT	58 blows / 13 cm ®	---	---	---				

DS = Disturbed Sample, SPT = Standard Penetration Test, UDS = Undisturbed Sample, ® = Refusal.

Annexure I
Borehole Log

Borehole No. BH-01
Location Substation, Gandhinagar

Borehole Depth 25.00 m
Water Table 0.60 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m.)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour
1	0.00-0.50	DS	---	---	---	---	0.00	Bluish grey to grey, moist, loose to medium dense, sandy silt.	Little	Grey
2	0.50-1.00	DS	---	---	---	---				
3	1.00-1.40	UDS	---	---	---	---				
4	1.50-1.95	SPT	2,3,3 (6)	---	---	---				
5	2.00-2.50	DS	---	---	---	---				
6	2.50-3.00	DS	---	---	---	---				
7	3.00-3.45	SPT	2,3,4 (7)	---	---	---				
8	3.50-4.00	DS	---	---	---	---				
9	4.00-4.50	DS	---	---	---	---				
10	4.50-4.95	SPT	3,4,6 (10)	---	---	---				
11	5.00-5.50	DS	---	---	---	---				
12	5.50-6.00	DS	---	---	---	---				
13	6.00-6.45	SPT	7,8,12 (20)	---	---	---				
14	6.50-7.00	DS	---	---	---	---				
15	7.00-7.50	DS	---	---	---	---				
16	7.50-7.95	SPT	16,24,37 (61)	---	---	---	7.50	Bluish grey, moist, dense to very dense, silty sand.		
17	8.00-8.50	DS	---	---	---	---	9.00	Blackish grey, moist, hard, decomposed sedimentary rock.		
18	8.50-9.00	DS	---	---	---	---				
19	9.00-9.38	SPT	19,38,57 blows / 8 cm ®	---	---	---				
20	9.50-10.00	DS	---	---	---	---				
21	10.00-10.50	DS	---	---	---	---				
22	10.50-10.75	SPT	20,58 blows / 10 cm ®	---	---	---				
23	11.00-11.50	DS	---	---	---	---				
24	11.50-12.00	DS	---	---	---	---				
25	12.00-12.22	SPT	25,54 blows / 7 cm ®	---	---	---				
26	12.50-13.00	DS	---	---	---	---				
27	13.00-13.50	DS	---	---	---	---				
28	13.50-13.76	SPT	29,59 blows / 11 cm ®	---	---	---				

DS = Disturbed Sample, SPT = Standard Penetration Test, UDS = Undisturbed Sample, ® = Refusal.

Annexure I
Borehole Log

Borehole No. BH-01
Location Substation, Gandhinagar

Borehole Depth 25.00 m
Water Table 0.60 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m.)	Recovery (%)	RQD (%)			Water loss	Colour
29	14.00-14.50	DS	---	---	---	---	25.00	Blackish grey, moist, hard, decomposed sedimentary rock.	Little	Grey
30	14.50-15.00	DS	---	---	---	---				
31	15.00-15.05	SPT	63 blows / 5 cm ®	---	---	---				
32	15.50-16.00	DS	---	---	---	---				
33	16.00-16.50	DS	---	---	---	---				
34	16.50-16.72	SPT	48,67 blows / 7 cm ®	---	---	---				
35	17.00-17.50	DS	---	---	---	---				
36	17.50-18.00	DS	---	---	---	---				
37	18.00-18.08	SPT	55 blows / 8 cm ®	---	---	---				
38	18.50-19.00	DS	---	---	---	---				
39	19.00-19.50	DS	---	---	---	---				
40	19.50-19.54	SPT	58 blows / 4 cm ®	---	---	---				
41	20.00-20.50	DS	---	---	---	---				
42	20.50-21.00	DS	---	---	---	---				
43	21.00-21.24	SPT	41,69 blows / 9 cm ®	---	---	---				
44	21.50-22.00	DS	---	---	---	---				
45	22.00-22.50	DS	---	---	---	---				
46	22.50-22.60	SPT	62 blows / 10 cm ®	---	---	---				
47	23.00-23.50	DS	---	---	---	---				
48	23.50-24.00	DS	---	---	---	---				
49	24.00-24.04	SPT	52 blows / 4 cm ®	---	---	---				
50	24.50-25.00	DS	---	---	---	---				
51	25.00-25.05	SPT	59 blows / 5 cm ®	---	---	---				

DS = Disturbed Sample, SPT = Standard Penetration Test, UDS = Undisturbed Sample, ® = Refusal.

Annexure I
Borehole Log

Borehole No. BH-02
Location Substation, Gandhinagar

Borehole Depth 25.00 m
Water Table 0.70 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer	Lithology	Return water			
No.	Depth (m.)		"N" value	Core length (m.)	Recovery (%)	RQD (%)	Depth (m)		Water loss	Colour		
1	0.00-0.50	DS	---	---	---	---	0.00	Bluish grey to grey, moist, loose to medium dense, silty sand.				
2	0.50-1.00	DS	---	---	---	---						
3	1.00-1.40	UDS	---	---	---	---						
4	1.50-1.95	SPT	2,3,4 (7)	---	---	---						
5	2.00-2.40	DS	---	---	---	---						
6	2.50-3.00	DS	---	---	---	---						
7	3.00-3.45	SPT	2,4,6 (10)	---	---	---						
8	3.50-4.00	DS	---	---	---	---						
9	4.00-4.50	DS	---	---	---	---						
10	4.50-4.95	SPT	3,5,8 (13)	---	---	---						
11	5.00-5.50	DS	---	---	---	---						
12	5.50-6.00	DS	---	---	---	---						
13	6.00-6.45	SPT	13,15,15 (30)	---	---	---	6.00	Bluish grey, moist, dense to very dense, silty sand.	Little	Grey		
14	6.50-7.00	DS	---	---	---	---						
15	7.00-7.50	DS	---	---	---	---						
16	7.50-7.95	SPT	15,19,31 (50)	---	---	---						
17	8.00-8.50	DS	---	---	---	---						
18	8.50-9.00	DS	---	---	---	---						
19	9.00-9.39	SPT	21,45,52 blows / 9 cm ®	---	---	---	9.00	Blackish grey, moist, hard, decomposed sedimentary rock.				
20	9.50-10.00	DS	---	---	---	---						
21	10.00-10.50	DS	---	---	---	---						
22	10.50-10.72	SPT	41,67 blows / 7 cm ®	---	---	---						
23	11.00-11.50	DS	---	---	---	---						
24	11.50-12.00	DS	---	---	---	---						
25	12.00-12.23	SPT	38,59 blows / 8 cm ®	---	---	---						
26	12.50-13.00	DS	---	---	---	---						
27	13.00-13.50	DS	---	---	---	---						
28	13.50-13.75	SPT	49,61 blows / 10 cm ®	---	---	---						
29	14.00-14.50	DS	---	---	---	---						

DS = Disturbed Sample, SPT = Standard Penetration Test, UDS = Undisturbed Sample, ® = Refusal.

Annexure I
Borehole Log

Borehole No. BH-02
Location Substation, Gandhinagar

Borehole Depth 25.00 m
Water Table 0.70 m
Boring/Drilling Rotary core drilling
Hole Diameter NX/NW

Run		Type of sample	Soil sample	Core sample			Layer Depth (m)	Lithology	Return water	
No.	Depth (m.)		"N" value	Core length (m.)	Recovery (%)	RQD (%)			Water loss	Colour
30	14.50-15.00	DS	---	---	---	---	25.00	Blackish grey, moist, hard, decomposed sedimentary rock.	Little	Grey
31	15.00-15.20	SPT	37,68 blows / 5 cm ®	---	---	---				
32	15.50-16.00	DS	---	---	---	---				
33	16.00-16.50	DS	---	---	---	---				
34	16.50-16.57	SPT	71 blows / 7 cm ®	---	---	---				
35	17.00-17.50	DS	---	---	---	---				
36	17.50-18.00	DS	---	---	---	---				
37	18.00-18.09	SPT	63 blows / 9 cm ®	---	---	---				
38	18.50-19.00	DS	---	---	---	---				
39	19.00-19.50	DS	---	---	---	---				
40	19.50-19.55	SPT	51 blows / 5 cm ®	---	---	---				
41	20.00-20.50	DS	---	---	---	---				
42	20.50-21.00	DS	---	---	---	---				
43	21.00-21.03	SPT	53 blows / 3 cm ®	---	---	---				
44	21.50-22.00	DS	---	---	---	---				
45	22.00-22.50	DS	---	---	---	---				
46	22.50-22.58	SPT	65 blows / 8 cm ®	---	---	---				
47	23.00-23.50	DS	---	---	---	---				
48	23.50-24.00	DS	---	---	---	---				
49	24.00-24.09	SPT	62 blows / 9 cm ®	---	---	---				
50	24.50-25.00	DS	---	---	---	---				
51	25.00-25.07	SPT	55 blows / 7 cm ®	---	---	---				

SPT = Standard Penetration Test, UDS = Undisturbed Sample, ® = Refusal.

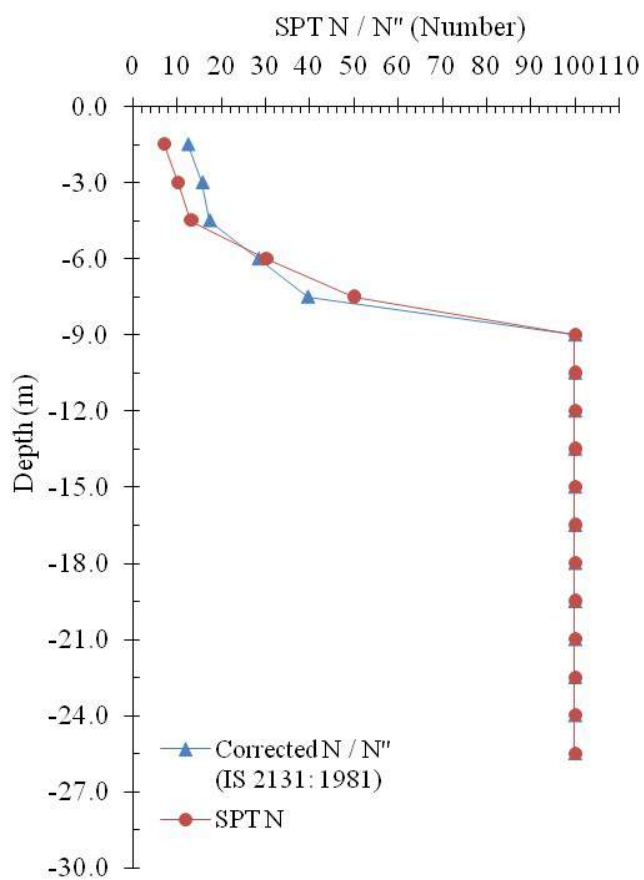


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

Annexure – II Corrected & Uncorrected SPT Curves

i) BH – 2 , Gandhi Nagar



Annexure - III
Laboratory Test Result on Soil Sample

Location : Sub Station, Campbell Bay

BoreHole No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test		
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)
1	1.00	UDS	Clayey Silt	100	100	100	100	100	98.86	96.06	0	4	80	16	42	23	19	---	CI	2.67	---	---	---	1.94	44.68	UU	0.21	6
1	4.00	UDS	Clayey Silt	100	100	100	100	99.62	98.22	95.87	0	4	79	17	45	24	21	---	CI	2.68	---	---	---	1.95	47.25	UU	0.23	5
1	9.00	SPT	Clayey Silt	100	100	100	99.23	97.62	93.55	89.95	0	10	77	13	37	20	17	---	CI	2.67	---	---	---	---	---	---	---	---
1	13.50	SPT	Clayey Silt	100	100	100	100	99.15	98.05	95	0	5	77	18	41	20	21	---	CI	2.68	---	---	---	---	---	---	---	---
1	18.00	SPT	Clayey Silt	100	100	100	99.67	98.72	98.02	97.06	0	3	82	15	39	20	19	---	CI	2.68	---	---	---	---	---	---	---	---
1	22.50	SPT	Clayey Silt	100	100	100	100	99.42	97.26	93.94	0	6	76	18	40	18	22	---	CI	2.67	---	---	---	---	---	---	---	---

UDS = Undisturbed Soil Sample, SPT = Standard Penetration Test, DS = Direct Shear Test, NP = Non Plastic.

Annexure - III
Laboratory Test Result on Soil Sample

Location : Sub Station, Vijay Nagar

BoreHole No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test		
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)
1	3.00	SPT	Sandy Silt	100	98.76	96.86	94.86	92.36	90.22	62.86	0	37	53	10	37	19	18	---	CI	2.66	---	---	---	1.90	---	DS	0.19	27
1	6.00	SPT	Sandy Silt	100	99.24	97.86	94.87	92.14	90.02	54.26	0	46	46	8	40	18	22	---	CI	2.67	---	---	---	---	---	---	---	---
1	9.00	SPT	Silty fine sand	100	99.24	97.86	96.24	93.87	54.56	17	0	83	17	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
1	12.00	SPT	Silty fine sand	98.76	98.38	97.15	95.46	86.58	46.30	9.42	1	90	9	0	---	---	NP	---	SM	2.61	---	---	---	---	---	DS	0.03	35
1	19.50	SPT	Silty fine sand	99	98.24	96.86	94.78	91.86	49.68	10	1	89	10	0	---	---	NP	---	SM	2.61	---	---	---	---	---	---	---	---

UDS = Undisturbed Soil Sample, SPT = Standard Penetration Test, DS = Direct Shear Test, NP = Non Plastic.

Annexure - III
Laboratory Test Result on Soil Sample

Location : Sub Station, Gandhi Nagar

BoreHole No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test		
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)
1	1.00	UDS	Sandy silt	100	100	99.45	98.56	93.86	84.68	69	0	31	61	8	32	14	18	---	CL	2.67	---	---	---	1.89	27.25	UU	0.20	10
1	7.50	SPT	Silty fine sand	100	100	99.45	97.76	94.51	61.23	23.95	0	76	24	0	---	---	NP	---	SM	2.66	---	---	---	1.86	---	DS	0.07	33
1	9.00	SPT	Clayey silt	100	100	100	100	100	100	100	0	0	87	13	34	18	16	---	CL	2.65	---	---	---	---	---	---	---	---
1	13.50	SPT	Clayey silt	100	100	100	100	100	100	100	0	0	84	16	31	18	13	---	CL	2.67	---	---	---	---	---	---	---	---
1	18.00	SPT	Clayey silt	100	100	100	99.89	99.67	99.35	99	0	1	85	14	32	17	15	---	CL	2.65	---	---	---	---	---	---	---	---
2	1.00	SPT	Silty fine sand	100	100	99.45	98.64	97.12	54.56	23	0	77	23	0	---	---	NP	---	SM	2.65	---	---	---	1.83	---	DS	0.08	32
2	7.50	SPT	Silty fine sand	100	99.54	97.89	96.68	94.22	48.86	14	0	86	14	0	---	---	NP	---	SM	2.62	---	---	---	1.87	---	DS	0.05	34
2	9.00	SPT	Clayey silt	100	100	100	99.84	99.69	99.46	99	0	1	85	14	33	16	17	---	CL	---	---	---	---	---	---	---	---	---
2	19.50	SPT	Clayey silt	100	100	100	99.78	99.46	98.64	98	0	2	83	15	33	19	14	---	CL	2.68	---	---	---	---	---	---	---	---
2	24.00	SPT	Clayey silt	100	100	100	100	100	100	100	0	0	85	15	31	17	14	---	CL	2.67	---	---	---	---	---	---	---	---

UDS = Undisturbed Soil Sample, SPT = Standard Penetration Test, DS = Direct Shear Test, NP = Non Plastic, UU = Unconsolidated Undrained shear strength



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Annexure – IV Field Photographs



Sub-station Capmbell Bay



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Sub-station Gandhinagar



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Sub-station Vijaynagar

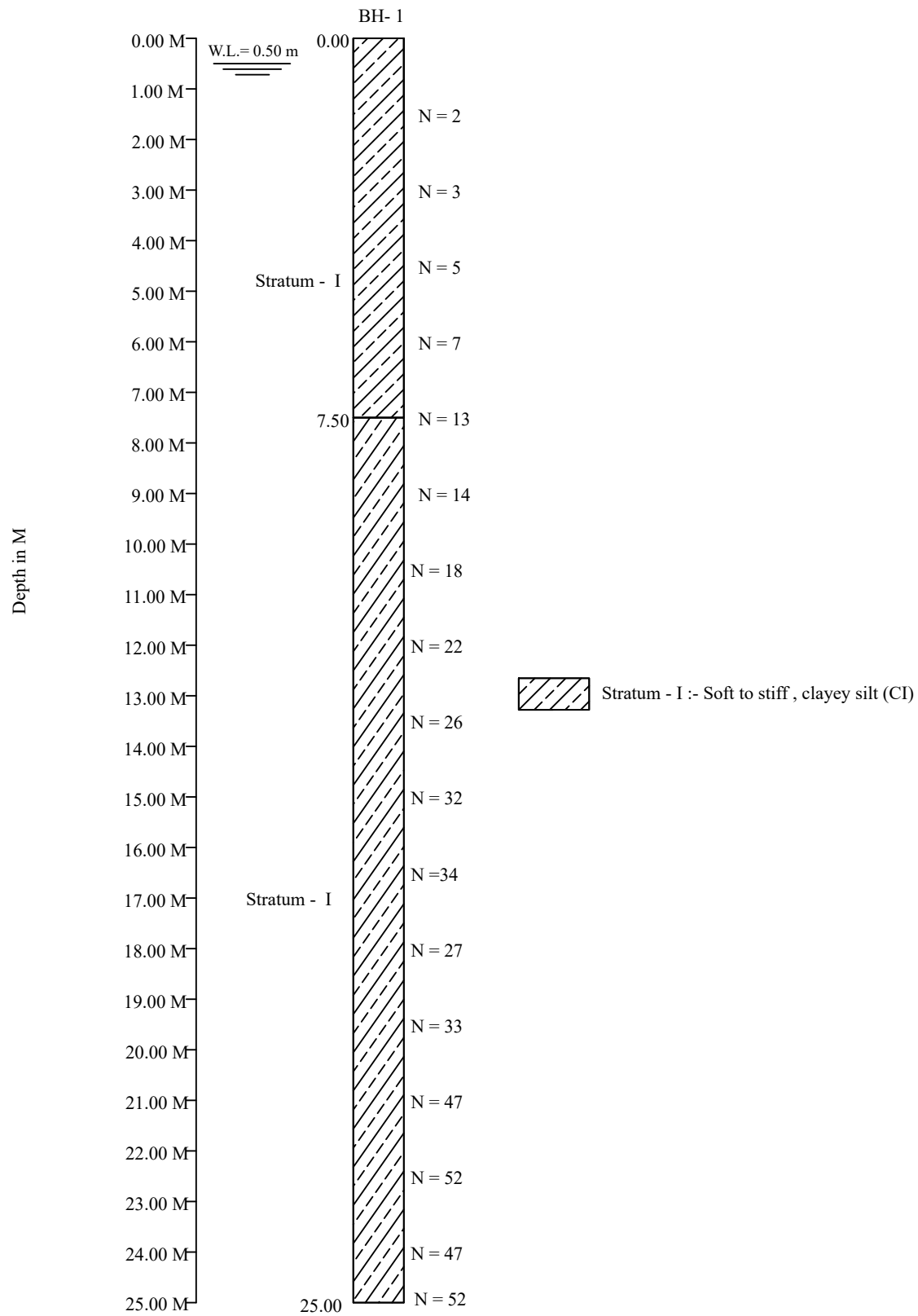


Fig 1 a:- Graphical Borehole Log for Sub-station Campbell Bay

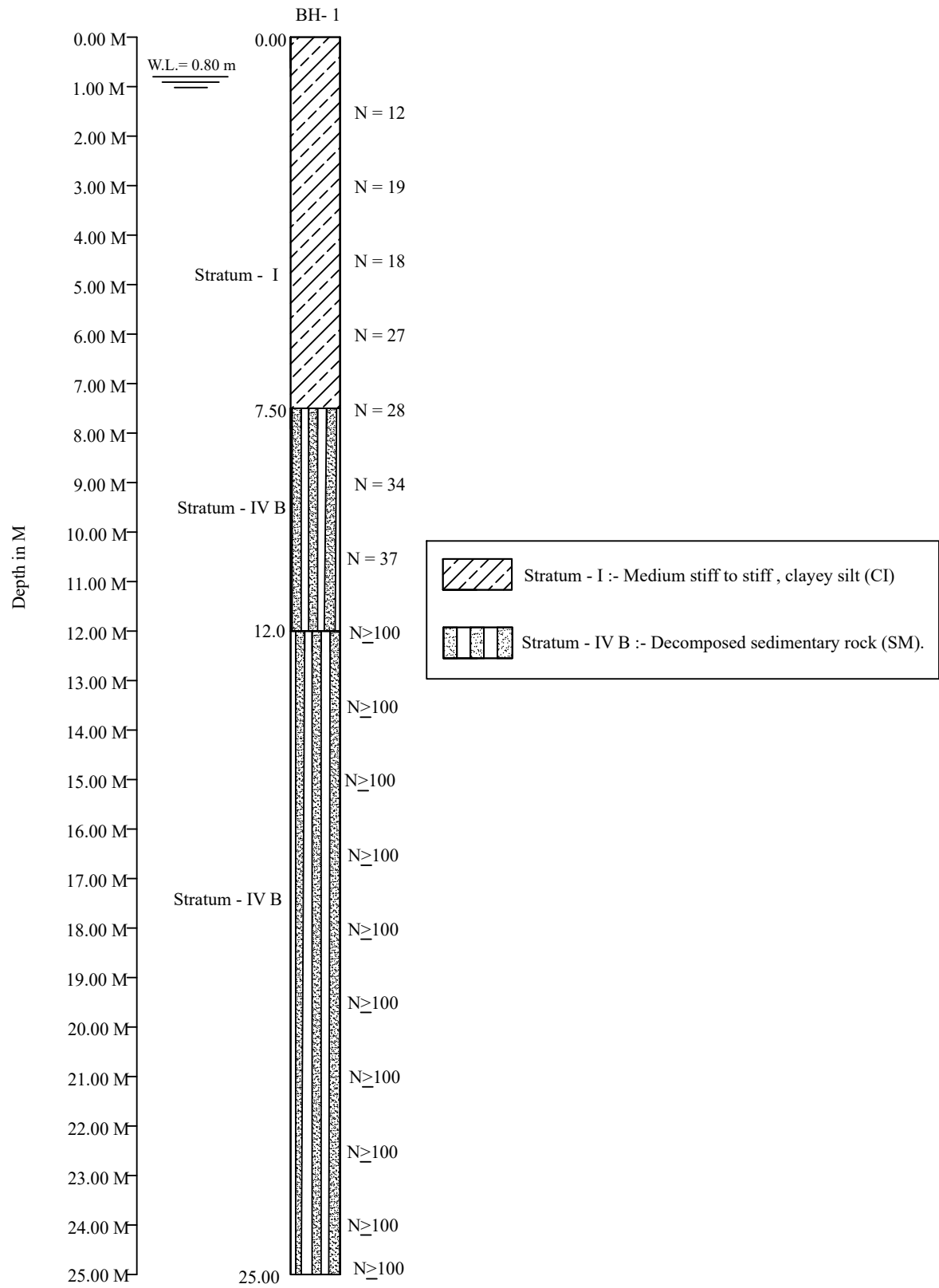


Fig 1b :-Graphical Borehole Log for Sub-station Vijay nagar.

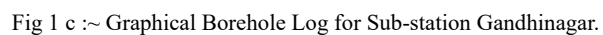


Fig 1 c :~ Graphical Borehole Log for Sub-station Gandhinagar.

PART -5

TRIAL PIT

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
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Report on

Trial Pit for 108 MW Gas based Power Plant at Great Nicobar Island, India

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1.3 Laboratory Investigation	

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Field Photographs	Annexure – IV

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Sub-soil Profile	Fig. 2

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
DATE	September, 2025

1.0 INTRODUCTION

1.1 General

For construction & set-up of power infrastructure in multiple phases with LNG based Gas Engine, PV Solar and Transmission System at Great Nicobar Island, trial pit has been excavated for fulfillment the purpose of geotechnical investigation (DPR). Five numbers of trial pits was dug as per instruction provided by NTPC Limited (A Government of India Enterprise).

1.2 Purpose

They provide an excellent opportunity to collect samples of soil for laboratory testing to determine strength, and other engineering parameters. Trial pits allow geotechnical engineers to directly observe and log the different soil types, their layers, and their overall structure in their natural state.

1.3 Laboratory Investigation

The following laboratory tests were conducted as per the provision of different sections of relevant IS codes (IS: 2720) to determine the index and the relevant engineering properties of the subsurface deposits and subsequently to finalize the foundation parameters.

For soil samples

- (a) Grain size analysis.
- (b) Test for liquid limit, plastic limit.
- (c) Test for Specific Gravity.
- (d) Shear for Cohesion & Angle of internal friction.
- (e) Field Density.
- (f) Standard Proctor Test.

Core cutter method has been performed to determine field density.

Test results have been presented in Annexure – II.

Annexure I**Trial Pit Log**

Trial Pit No.: 1

Location: Galathea, Great Nicobar

Co-ordinate: E 593460, N 754960

Trial Pit Depth: 4.00 m

Water Table: 0.50 m

Sl. No.	Depth (m)	Size of Excavation (m)	Nature of Soil	Water Table	Colour of Soil	Visual Classification	Side Wall collapse
1	0.00 - 1.00	2.0 x 2.0	Silty Sand	Visible	Blackish grey	Blackish grey, wet, silty sand.	Collapse
2	1.00 - 2.00	2.0 x 2.0	Silty Sand	Visible	Blackish grey	Blackish grey, wet, silty sand.	
3	2.00 - 3.00	2.0 x 2.0	Silty Sand	Visible	Blackish grey	Blackish grey, wet, silty sand.	
4	3.00 - 4.00	2.0 x 2.0	Silty Sand	Visible	Blackish grey	Blackish grey, wet, silty sand.	

Annexure I

Trial Pit Log

Trial Pit Depth:4.00 m

Water Table: 0.20 m

Trial Pit No.: 2
Location: Galathea, Great Nicobar
Co-ordinate: E 593580, N 754900

Sl. No.	Depth (m)	Size of Excavation (m)	Nature of Soil	Water Table	Colour of Soil	Visual Classification	Side Wall collapse
1	0.00 - 1.00	2.0 x 2.0	Silty Sand	Visible	Brown	Brown, wet, silty sand.	Collapse
2	1.00 - 2.00	2.0 x 2.0	Silty Sand	Visible	Brown	Brown, wet, silty sand.	
3	2.00 - 3.00	2.0 x 2.0	Silty Sand	Visible	Greyish Brown	Greyish brown, wet, silty sand.	
4	3.00 - 4.00	2.0 x 2.0	Silty Sand	Visible	Greyish Brown	Greyish brown, wet, silty sand.	

Annexure I

Trial Pit Log

Trial Pit Depth:4.00 m

Water Table: 0.50 m

Trial Pit No.: 3

Location: Galathea, Great Nicobar

Co-ordinate: E 593610, N 754770

Sl. No.	Depth (m)	Size of Excavation (m)	Nature of Soil	Water Table	Colour of Soil	Visual Classification	Side Wall collapse
1	0.00 - 1.00	2.0 x 2.0	Silty Sand with clay	Visible	Greyish Brown	Greyish brown, wet, fine silty sand with clay mix.	Collapse
2	1.00 - 2.00	2.0 x 2.0	Silty Sand with clay	Visible	Greyish Brown	Greyish brown, wet, fine silty sand with clay mix.	
3	2.00 - 3.00	2.0 x 2.0	Silty Sand with clay	Visible	Greyish Brown	Greyish brown, wet, fine silty sand with clay mix.	
4	3.00 - 4.00	2.0 x 2.0	Silty Sand with clay	Visible	Greyish Brown	Greyish brown, wet, fine silty sand with clay mix.	

Annexure I

Trial Pit Log

Trial Pit Depth:4.00 m

Water Table: 0.20 m

Trial Pit No.: 4

Location: Galathea, Great Nicobar

Co-ordinate: E 593270, N 755030

Sl. No.	Depth (m)	Size of Excavation (m)	Nature of Soil	Water Table	Colour of Soil	Visual Classification	Side Wall collapse
1	0.00 - 1.00	2.0 x 2.0	Silty Sand	Visible	Brownish grey	Brownish grey, wet, fine silty sand.	Collapse
2	1.00 - 2.00	2.0 x 2.0	Silty Sand	Visible	Brownish grey	Brownish grey, wet, fine silty sand.	
3	2.00 - 3.00	2.0 x 2.0	Silty Sand	Visible	Brownish grey	Brownish grey, wet, fine silty sand.	
4	3.00 - 4.00	2.0 x 2.0	Silty Sand	Visible	Brownish grey	Brownish grey, wet, fine silty sand.	

Annexure I**Trial Pit Log**

Trial Pit No.: 5

Location: Galathea, Great Nicobar

Co-ordinate: E 593170, N 755210

Trial Pit Depth: 4.00 m

Water Table: 0.20 m

Sl. No.	Depth (m)	Size of Excavation (m)	Nature of Soil	Water Table	Colour of Soil	Visual Classification	Side Wall collapse
1	0.00 - 1.00	2.0 x 2.0	Clayey silt with fine sand	Visible	Grey	Grey, moist, clayey silt with fine sand.	No
2	1.00 - 2.00	2.0 x 2.0	Clayey silt with fine sand	Visible	Grey	Grey, moist, clayey silt with fine sand.	
3	2.00 - 3.00	2.0 x 2.0	Clayey silt with fine sand	Visible	Grey	Grey, moist, clayey silt with fine sand.	
4	3.00 - 4.00	2.0 x 2.0	Clayey silt with fine sand	Visible	Grey	Grey, moist, clayey silt with fine sand.	

Annexure - II
Laboratory Test Result

Trial Pit No.	Depth (m.)	Sample Type	Sample Description	Sieve Analysis							Grain Size				Atterberg Limit				IS Classification	Specific Gravity	Free Swell Index	Swelling Potential (kg/sq. cm)	Dry Density	Bulk Density	Natural Water Content (%)	Shear Test		
				4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrinkage Limit (%)								Type of Test	Cohesion (Kg /sq.cm)	Angle of Friction (Degree)
1	2.00	D	Silty fine sand	99.59	98.15	96.78	95.73	95.18	71.67	15.62	0	84	16	0	---	---	NP	---	SM	2.63	---	---	---	1.79	---	DS	0.09	31
1	3.50	D	Silty fine sand	100	99.05	98.95	97.89	96.11	68.75	14.38	0	86	14	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
2	2.00	D	Silty fine sand	100	99.92	99.85	99.85	92.28	91.58	22.95	0	77	23	0	---	---	NP	---	SM	---	---	---	---	---	---	---	---	---
2	3.00	D	Silty fine sand	99	98.45	97.76	96.55	94.32	52.00	16.78	1	82	17	0	---	---	NP	---	SM	2.63	---	---	---	1.79	---	DS	0.08	32
3	1.00	D	Silty fine sand	100	100	100	99.14	98.82	96.30	36.48	0	64	30	6	---	---	NP	---	SM	2.65	---	---	---	1.83	---	---	---	---
3	3.00	D	Silty fine sand	100	100	99.46	98.56	97.86	57.56	25.00	0	75	25	0	---	---	NP	---	SM	2.63	---	---	---	1.83	---	DS	0.08	32
4	2.00	D	Silty fine sand	100	100	99.68	98.64	95.68	54.68	28	0	72	28	0	---	---	NP	---	SM	2.58	---	---	---	1.75	---	DS	0.13	29
4	4.00	D	Silty fine sand	100	100	100	100	98.85	52.08	22.11	0	78	22	0	---	---	NP	---	SM	2.64	---	---	---	---	---	---	---	---
5	1.00	SPT	Clayey silt	100	99.86	99.75	99.61	99.29	96.14	82.17	0	18	74	8	37	18	19	---	CI	2.67	---	---	---	1.87	---	---	---	---
5	3.50	SPT	Clayey silt	100	100	100	99.35	98.74	90.85	79.11	0	21	69	10	39	18	21	---	CI	2.67	---	---	---	---	---	---	---	---

D = Disturbed Sample, DS = Direct Shear Test, NP = Non Plastic.

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

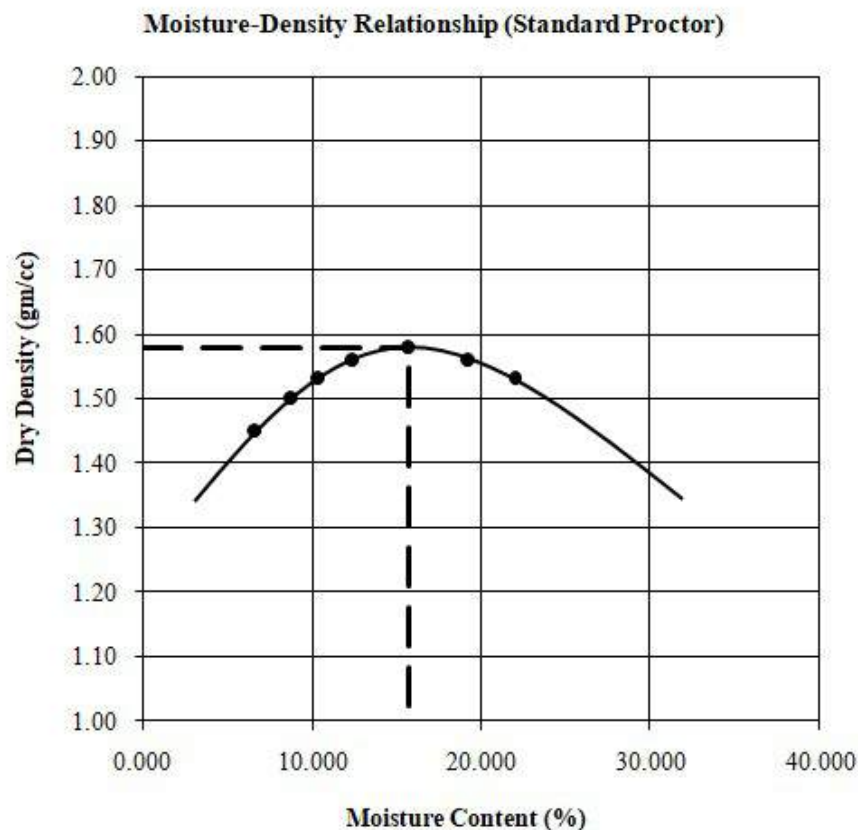
PROJECT	108 MW Gas Based Power Plant
CLIENT	NTPC Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GI/2025-26/R-06 (Rev.01)
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Annexure – III **PROCTOR TEST RESULTS**

Proctor test has been conducted at proposed Trial Pit location for GNI Project. Proctor test has been conducted as per IS: 2720 (Part-7). Proctor test results have been presented in the tabular form.

Trial Pit – 1

Maximum Dry Density	1.58
Optimum Moisture Content From Graph :	15.68 %



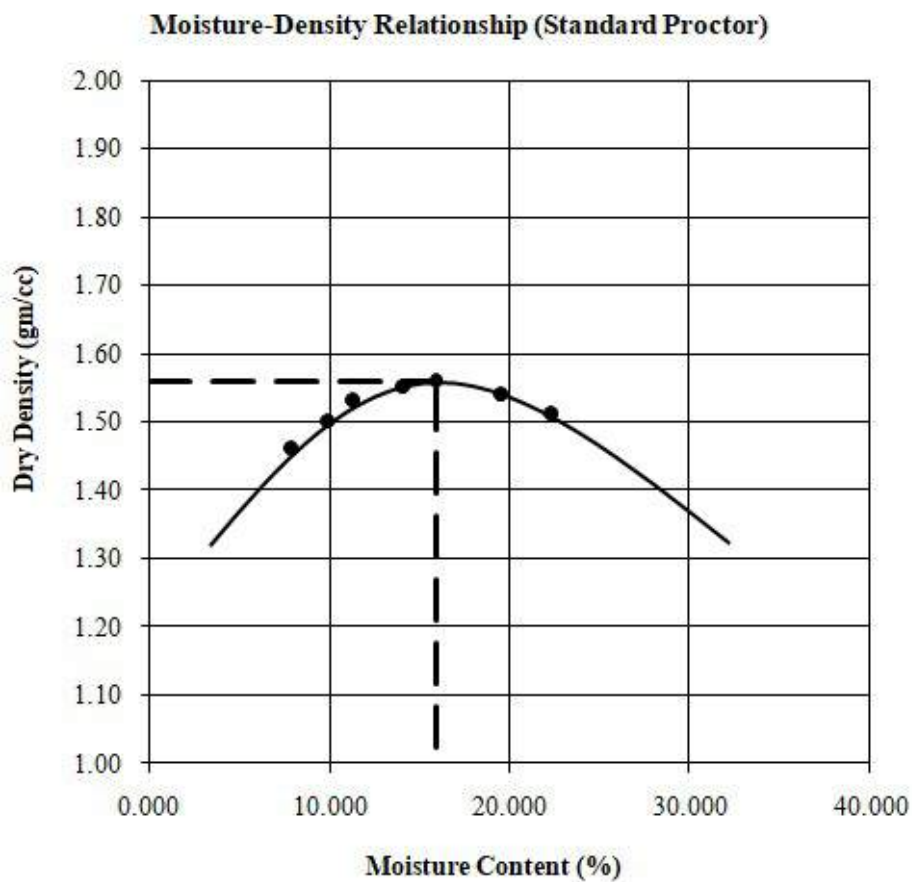


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Trial Pit – 2

Maximum Dry Density	1.56
Optimum Moisture Content From Graph :	15.89 %

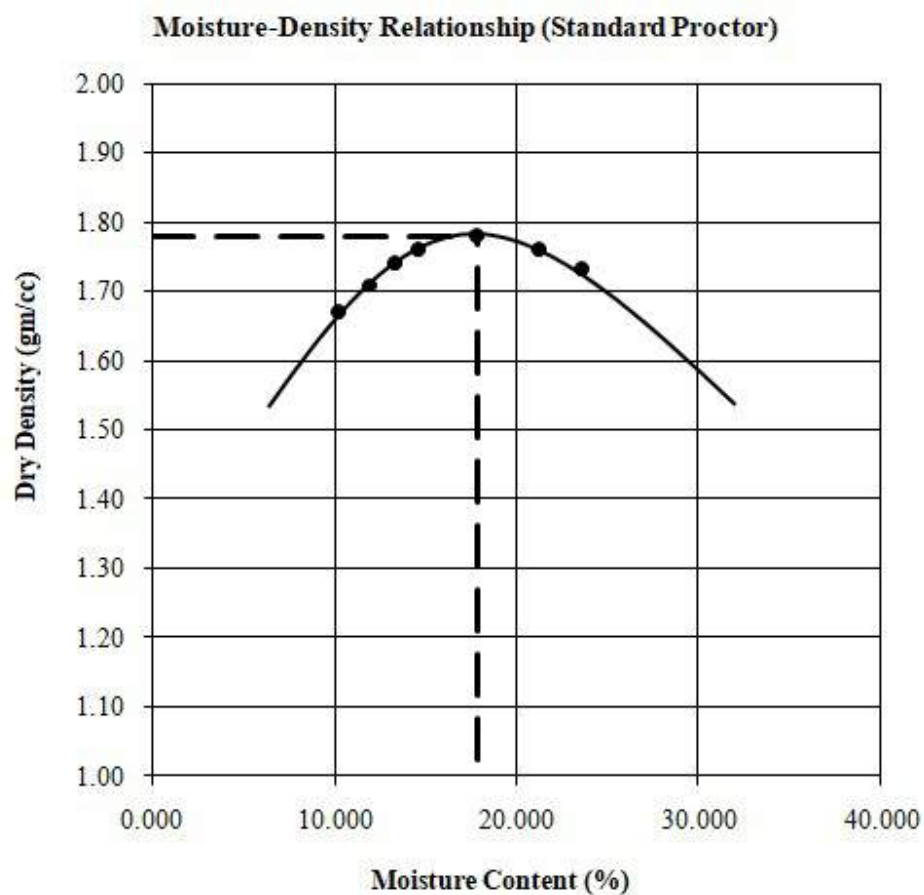


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Trial Pit – 3

Maximum Dry Density	1.78
Optimum Moisture Content From Graph :	17.88 %

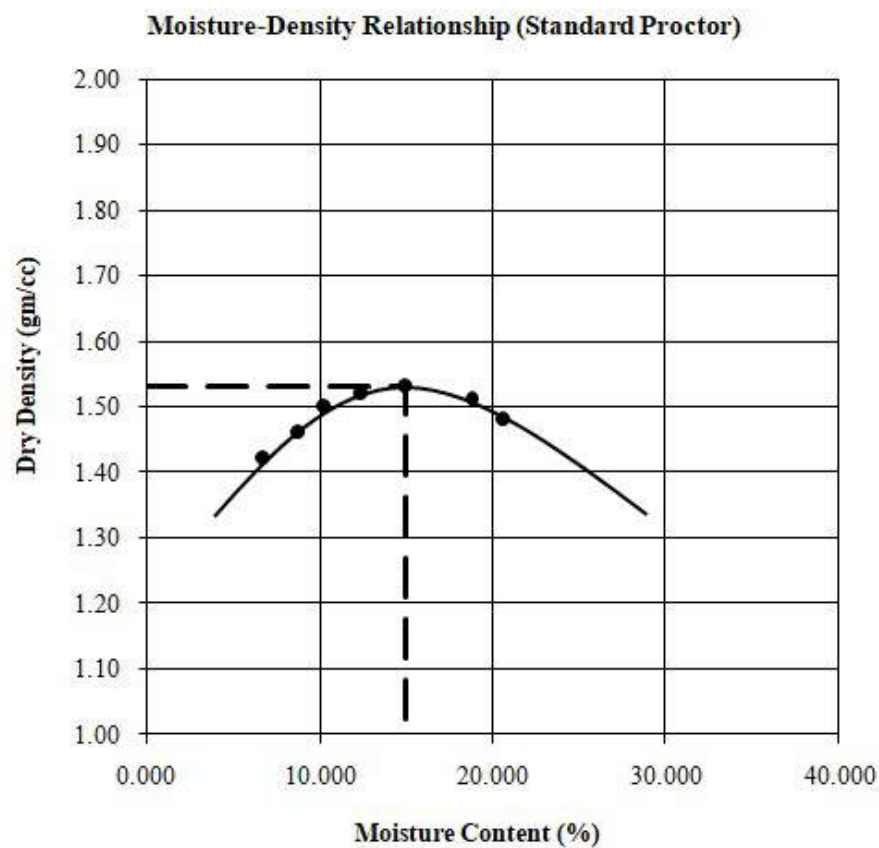


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Trial Pit – 4

Maximum Dry Density	1.53
Optimum Moisture Content From Graph :	14.98 %

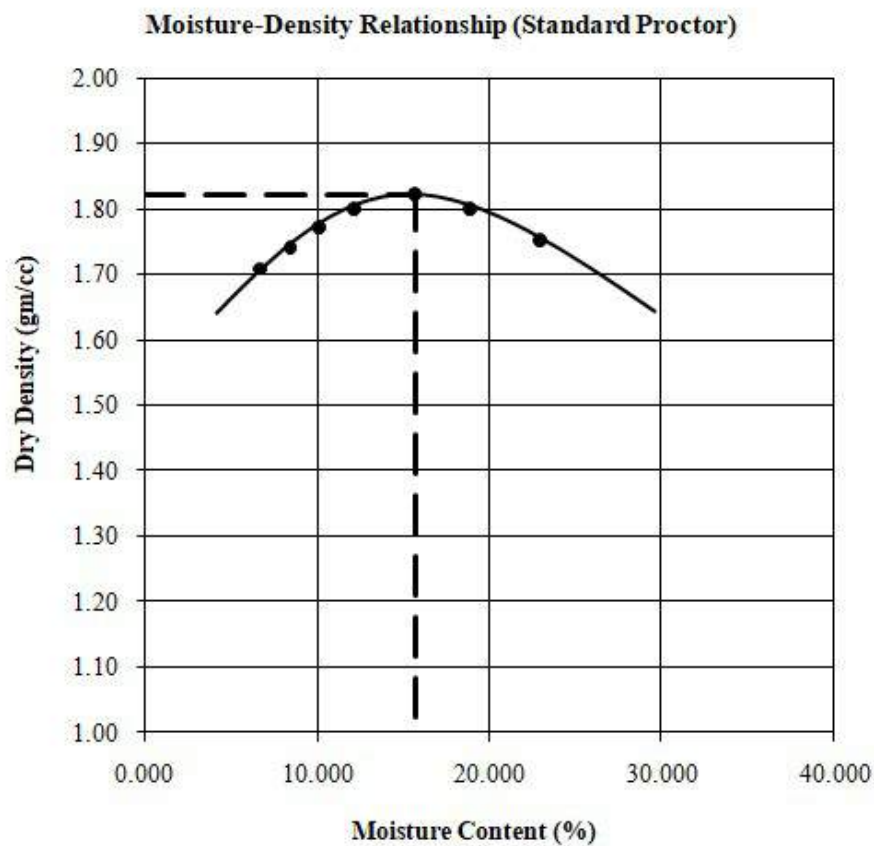


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Trial Pit – 5

Maximum Dry Density	1.82
Optimum Moisture Content From Graph :	15.68 %





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Annexure – IV Field Photographs



Trial Pit – 01



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Trial Pit – 02



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Trial Pit – 03



Trial Pit - 04

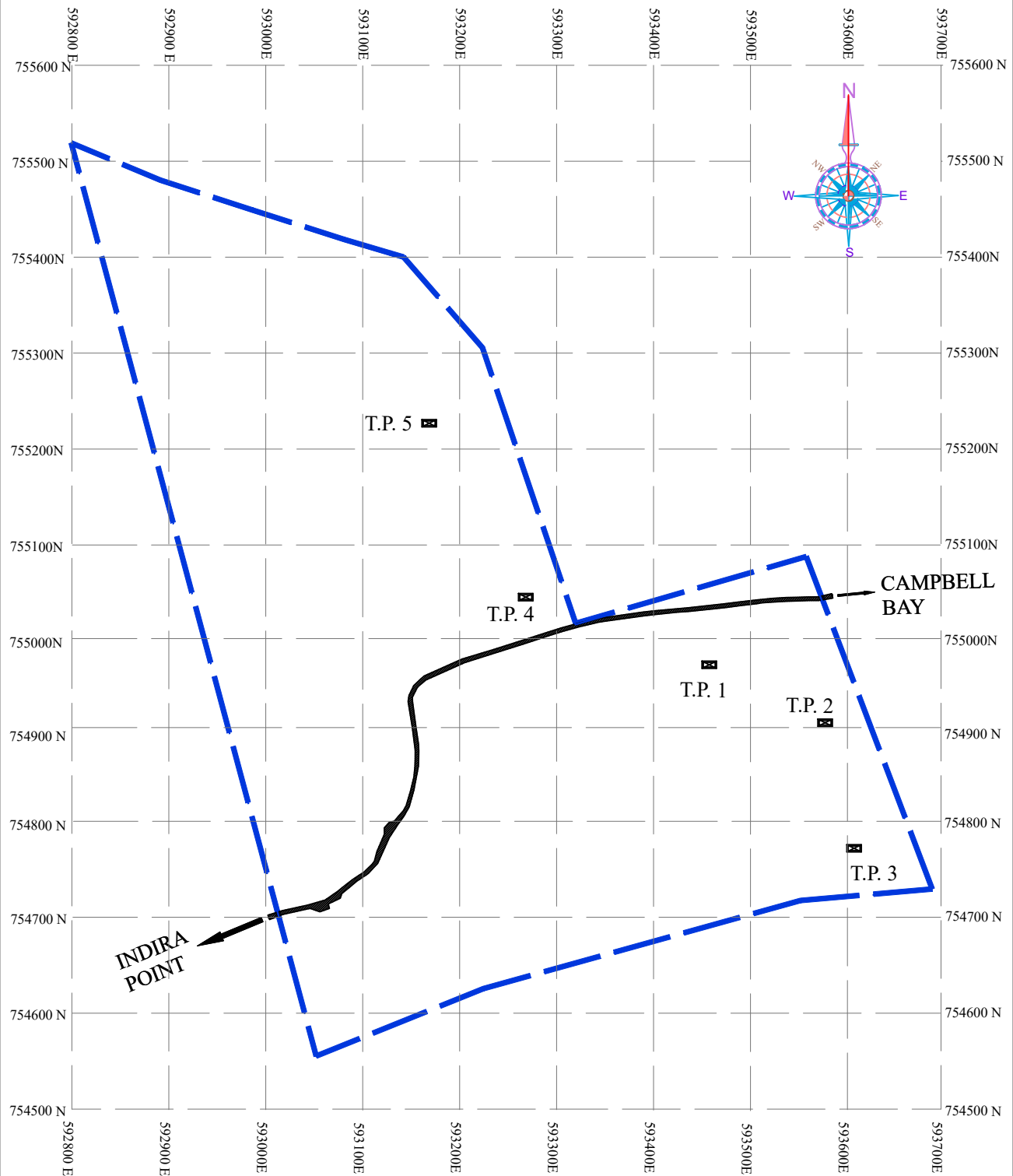


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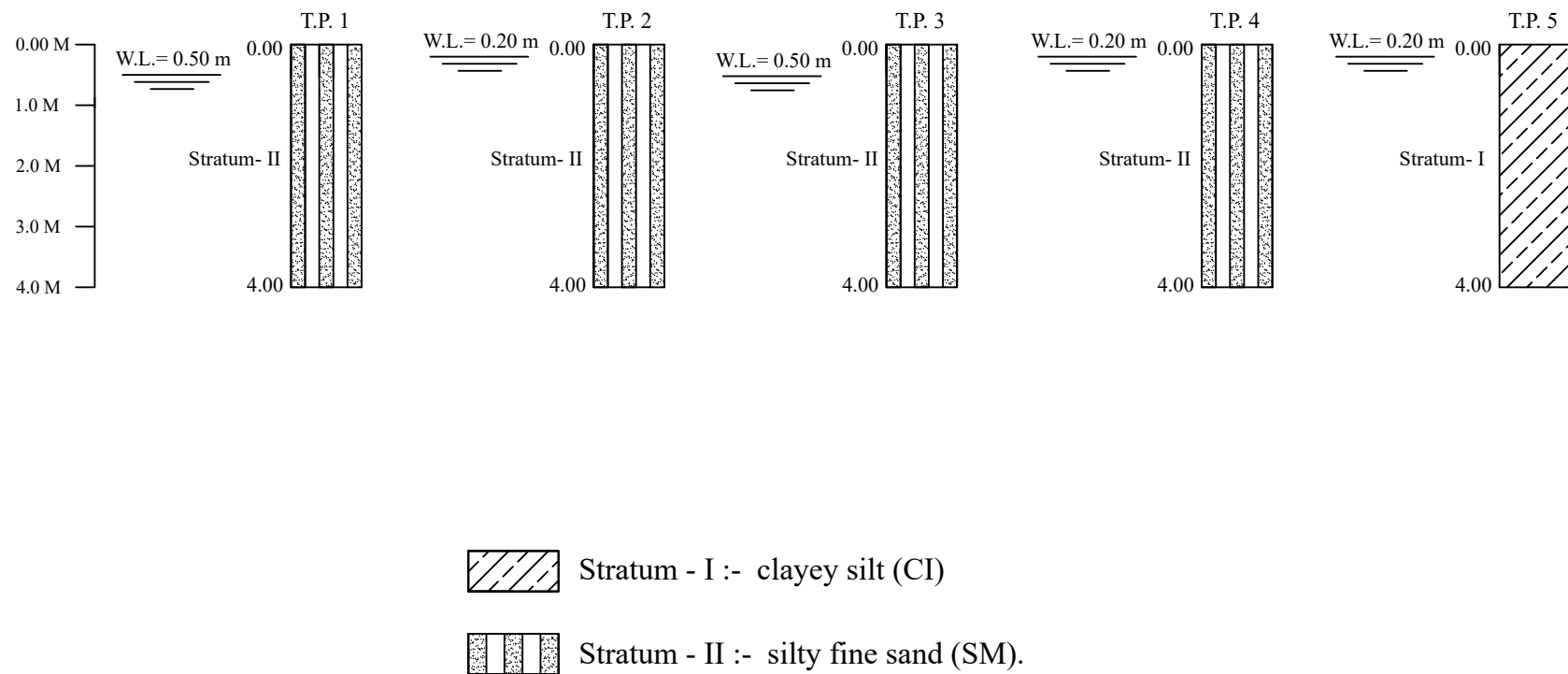


Trial Pit - 05



S.L. NO.	EASTING	NORTHING
T.P. 1	593460	754960
T.P. 2	593580	754900
T.P. 3	593610	754770
T.P. 4	593270	755030
T.P. 5	593170	755210

Trial Pit Location Plan
Fig 1



Graphical Representation for Trial Pit for GNI Project


Fig 2

D-1-9

ANNEXURE-D

WIND DESIGN CRITERIA

CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>एन टी सी NTPC</div>
1.00.00	<div>ANNEXURE-D (A)</div>		
	<div>CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT</div>		
	<p>All structures shall be designed for wind forces in accordance with IS:875 (Part-3) and as specified in this document. See Annexure –D(B) for site specific information.</p>		
	<p>Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.</p>		
	<p>Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.</p>		
1.00.00	<p>Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than “5” and/or if the fundamental frequency of the structure is less than 1 Hz.</p>		
	<p>Susceptibility of structures to across-wind forces, galloping, flutter, ovalling etc. should be examined and designed/detailed accordingly following the recommendations of IS:875(Part-3) and other relevant Indian standards.</p>		
	<p>It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects.</p>		
	<div>Damping in Structures</div>		
	<p>The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:</p>		
1.00.00	<div><div>a) Welded steel structures</div><div>: 1.0%</div></div>		
	<div><div>b) Bolted steel structures/RCC structures</div><div>: 2.0%</div></div>		
	<div><div>c) Prestressed concrete structures</div><div>: 1.6%</div></div>		
	<div><div>d)Steel stacks</div><div>:As per IS:6533 & CICIND Model Code whichever is more critical.</div></div>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART B BID DOC NO: CS-6401-001-2	D-1 CIVIL WORKS ANNEXURE D WIND DESIGN CRITERIA <div>Page 1 of 2</div>

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p style="text-align: right;"><u>ANNEXURE-D(B)</u></p> <p><u>SITE SPECIFIC DESIGN PARAMETERS</u></p> <p>The various design parameters, as defined in IS: 875 (Part-3), to be adopted for the project site shall be as follows:</p> <p>a) The basic wind speed “V_b” at ten metres above the mean ground level : 44 metres/second</p> <p>b) The risk coefficient “K_1” : 1.07</p> <p>c) Category of terrain : Category-1</p> <p>d) Importance factor for Cyclonic region K_4: 1.15</p>			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW \pm 5 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART B BID DOC NO: CS-6401-001-2	D-1 CIVIL WORKS ANNEXURE D WIND DESIGN CRITERIA	Page 2 of 2	

D-1-9

**ANNEXURE-E
SIESMIC DESIGN CRITERIA**

EARTHQUAKE ENGINEERING STUDIES

EQD: 2025-12

Site Specific Design Earthquake Parameters for the 108MW LNG based Gas Engine Project on Nicobar Island Andaman and Nicobar



**DEPARTMENT OF EARTHQUAKE ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE – 247667, INDIA**

(December, 2025)

**Site Specific Design Earthquake Parameters for the 108MW
LNG based Gas Engine project on Nicobar Island
Andaman and Nicobar**

Project No. EQD- 6024/25-26

Sponsored By: **Fichtner Consulting Engineers Pvt. Ltd., Chennai**

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PREFACE

NTPC has been designated as the implementing agency for the construction of the LNG-based gas-engine power plant on Nicobar Island, Andaman and Nicobar Islands. Fichtner Consulting Engineers India Pvt Ltd. (FCEIPL), Chennai has been engaged to prepare the detailed project report for the power plant. The location of the project site are latitude 6.82°N and longitude 93.83°E . The site-specific earthquake parameter studies for seismic design of the structure of the Nicobar Gas Plant project were referred to Department of Earthquake Engineering, Indian Institute of Technology Roorkee. Accordingly, the Department has taken up the studies for site-specific earthquake parameters for the site.

The present document consists of recommendations made for site dependent spectra and time history of ground motion for seismic analysis of structures. The work reported here in was carried out by Prof. B.K. Maheshwari, Prof. M.L. Sharma, Prof. Yogendra Singh, Prof. Manish Shrikhande and Prof. Josodhir Das. Discussions held with FCEIPL officials regarding the site specific studies are acknowledged.

Roorkee
December 31, 2025

(B.K. Maheshwari)
Prof & Head and P.I.

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EXECUTIVE SUMMARY

NTPC has been designated as the implementing agency for the construction of the LNG-based gas-engine power plant on Nicobar Island, Andaman and Nicobar Islands. Fichtner Consulting Engineers India Pvt Ltd. (**FCEIPL**), Chennai has been engaged to prepare the detailed project report for the power plant. The location of the project site are latitude 6.82°N and longitude 93.83°E. The Nicobar Gas Plant site lies in seismic Zone-V as per the seismic zoning map of India incorporated in Indian Standard Criteria for Earthquake Resistant Design of Structures (IS: 1893 (Part 1): 2016). The recommendations for the site-specific earthquake design parameters for the site are based on the studies carried out related to the seismotectonics, local geology around the site, earthquake occurrences in the region. The methodology used in the present study is both deterministic seismic hazard analysis (DSHA) and probabilistic seismic hazard analysis (PSHA). Five seismogenic source zones have been identified for the site specific studies of this site based on the fault, seismicity and seismotectonic modelling. The attenuation relationships used in the present study are given by Parker et al. (2020) and Abrahamson and Gulerce (2020). The uniform seismic hazard response spectra have been obtained for two conditions i.e., 2% probability of exceedance in 50 years which is equivalent to 2475 years of return period and 10% probability of exceedance in 50 years or 475 years of return period. The response spectra have been estimated for the time periods 0.00, 0.01, 0.02, 0.03, 0.05, 0.075, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.5, 0.75, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 7.5 and 10.0 seconds.

Deterministic seismic hazard assessment provides estimated peak horizontal ground acceleration (PGA) as 0.519g for the maximum considered earthquake (MCE) at median level considering these earthquake parameters. Whereas, probabilistic seismic hazard assessment for this site provides, PGA of 0.149g for DBE (475 year return period) and PGA of 0.241g for MCE (2475 year return period).

The design acceleration response spectra for MCE and DBE conditions can be obtained by multiplying the spectral shape given in Table-III by respective PGA values.

Site Specific Design Earthquake Parameters for the 108MW LNG based Gas Engine project on Nicobar Island Andaman and Nicobar

1.0 INTRODUCTION

NTPC has been designated as the implementing agency for the construction of the LNG-based gas-engine power plant on Nicobar Island, Andaman and Nicobar Islands. Fichtner Consulting Engineers India Pvt Ltd. (**FCEIPL**), Chennai has been engaged to prepare the detailed project report (DPR) for the power plant. The location of the project site are latitude 6.82°N and longitude 93.83°E. The site-specific earthquake parameter studies for seismic design of the structure of the Nicobar Gas Plant project were referred to Department of Earthquake Engineering, Indian Institute of Technology, Roorkee. Accordingly, the Department has taken up the studies for site-specific earthquake parameters for the site.

The site lies in seismic Zone-V as per the seismic zoning map of India incorporated in Indian Standard Criteria for Earthquake Resistant Design of Structures (IS: 1893 (Part 1): 2016). The probable intensity of earthquake in seismic Zone- V corresponds to IX according to Comprehensive Intensity Scale (MSK-64) and structures designed as per recommended design parameters for this zone would generally prevent loss of human life and only repairable damage could occur. However, the recommended design parameters in IS: 1893(Part 1): 2016 are for preliminary design of important structures and to ensure seismic resistant plant and also to adequately safeguard heavy investment concentrated in one area, it is desirable to carryout site specific studies for final design of important structures.

For the purpose of seismotectonic modelling and seismic hazard assessment an area of $6^{\circ} \times 6^{\circ}$ area bounded by latitudes 3.8°N and 9.8°N and longitudes 90.8°E and 96.8°E for this site (Fig. 1a) has been considered. Fig. 1b shows the project site along with bathymetry and seismicity. The project site is represented by soil and on the basis of bore log information and N values, a shear wave velocity 300 m/s has been considered. DSHA and PSHA have been carried out for the hazard assessment of the site. GMPEs used are Parker et al. (2020) and Abrahamson and Gulerce (2020) applicable for the subduction zone. Based on the hazard assessment, the estimated peak ground acceleration (PGA) has been obtained as 0.519 g from the DSHA at median level

whereas the PSHA estimates for DBE (475 yrs return period) is 0.149g and the MCE (2475 yrs return period) is 0.241.

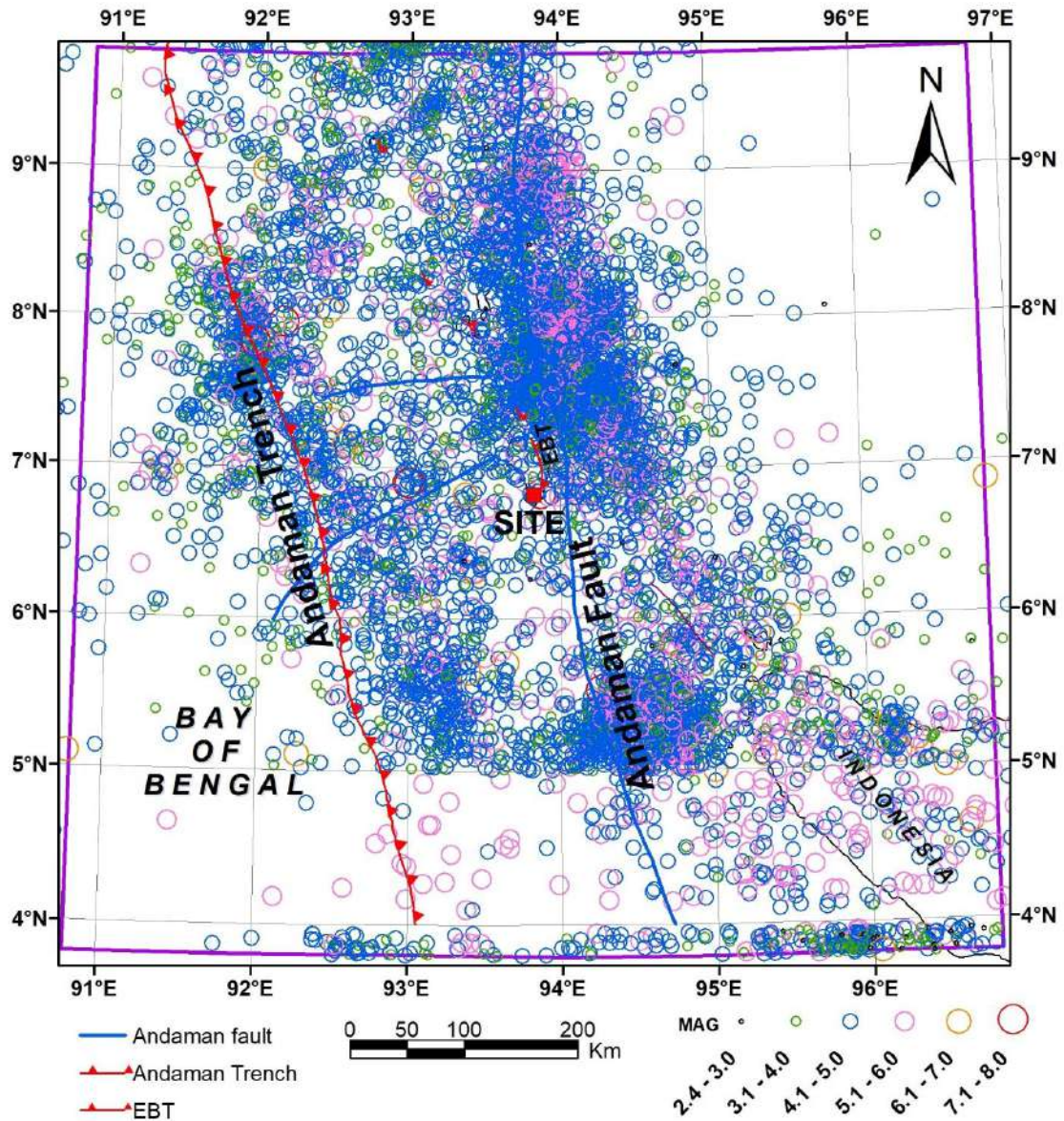


Fig. 1a Seismotectonics of the Nicobar Gas Plant Project study area.

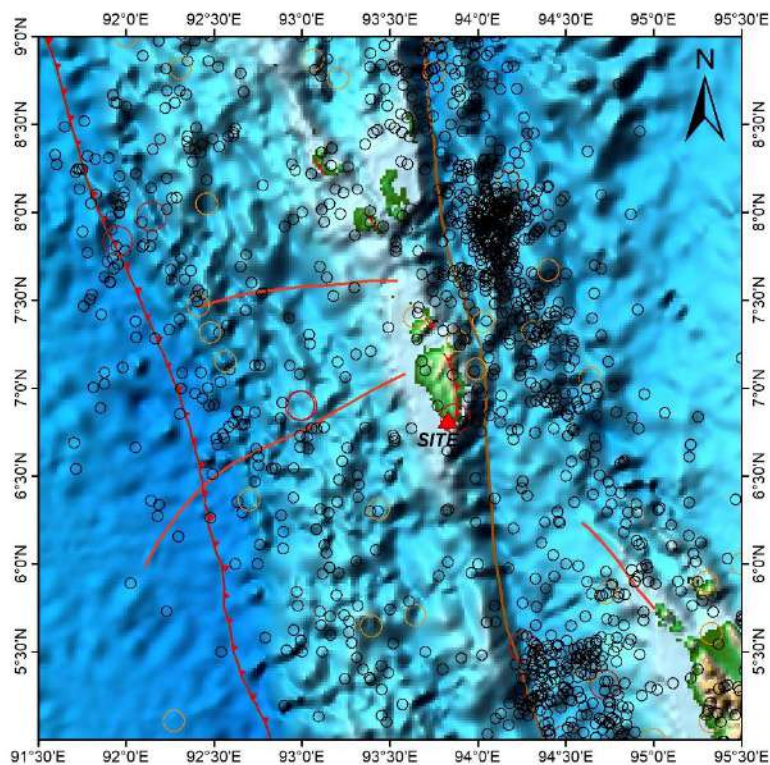


Fig. 1b Seismotectonic and bathymetry of the Nicobar Gas Plant Project area

2.0 REGIONAL GEOLOGY AND TECTONICS OF THE REGION

The Andaman and Nicobar island system is believed to have formed in Oligocene-Miocene times due to east-west compression of sediments derived from the Malayan shelf (Rodolfo, 1969a,b). The islands are chiefly constituted by rocks of Cretaceous serpentinites, ophiolites with radiolarian cherts, Cretaceous to Eocene cherty pelagic limestone, grit, conglomerate, and a thick section of Eocene-Oligocene flysch overlain by Neogene shallow water sediments. Older sedimentaries constitutes the oldest exposed rocks of these islands, occurring in sparsely distributed hillocks and knolls in South and Middle Andaman.

Generalised stratigraphic sequence and sediment character for the Andaman Islands region (source: Chatterjee, 1967; Eremenko and Sastri, 1977; and Roy, 1983)

Age	Formation	Generalised lithology	Max. thickness (meter)
Recent-Pleistocene		Beach and tidal deposits coral reef, raised beaches	
		Unconformity	
Pliocene-Miocene	Long	Foraminiferal clay, thin bands of silt	60

	Guiter	Foraminiferal limestone calcareous sandstone and siltstone	450
	Round	Chalk, sandstone, siltstone	520
	Strait	Sandstone, grit, conglomerate marl and siltstone	500
Oligocene- Late Eocene	Port Blair	Thick to massive sandstone, shale, siltstone	750
Paleocene- Late Cretaceous	Baratang	Shale, associated greywacks, Limestone	1370
Cretaceous	Port Meadow	Radiolarian chert, jaspers, quartzite, limestone, marble, Oceanic basement/ophiolite suite	500+

The oldest recognised Formation is the Baratang Formation and the lithological units are eugeosynclinal with changing facies, north and southwards, from the type area in Baratang Island. Whereas, in the type area, it is predominantly argillaceous, consisting of dark grey shale with subordinate amounts of feldspathic sandstones and algal limestones. This facies is typically exposed in the Bomlun-ta valley in Middle Andaman. Further northwards (north of Austen Strait) the Baratang Formation changes into an arenaceous facies consisting of thick-bedded greywacke and subgreywacke with irregular bodies of breccias and conglomerates, lying at the fringes of the main island (particularly around Bacon Bay). Although in Middle and South Andamans the boundary between the Baratang and the succeeding Port Blair Formation is either tectonic or not exposed, a basal conglomerate or grit is noticed in a few localities in the Baratang Island where the Port Blair Formation overlies the Baratang Formation.

Ultrabasic intrusives with its basic differentiates belonging to the Igneous series are exposed in North and Middle Andamans whereas the basic extrusives are exposed in the south (particularly south of Port Blair). The intrusive bodies occur as hill ranges, large hillocks of knolls, while the extrusives are seen in more level areas. The intrusives consist of augite andesite, basalt, crystalline tuff of felsitic composition and serpentinitised tuffs. This Igneous Series was presumably emplaced during the earth

movements when the later phases of deposition of the Baratang Formation was going on.

The Port Blair Formation is typically exposed in South Andaman in and around Port Blair. Good exposures are seen in the northeast part of the Baratang Island; and in Middle Andaman but not exposed in North Andaman. The sediments are eugeosynclinal flysch, consisting of thick-bedded greywacke alternated with shale or siltstones, laminated silty sandstones, and a few bands of grey blue calcareous sandstones. As compared to the older Baratang Formation, these rocks are better sorted, do not contain many rudaceous bodies and are free from igneous activities

Structurally the Andaman-Nicobar ridge is dominated by east-dipping nappes having gentler folding in the north part of the arc as compared to tighter folding and more intense deformation within the nappes further south off Sumatra (Weeks et al., 1967; Moore and Curray, 1980). Also the structures in the Cretaceous-Oligocene sequences are generally more deformed than those developed in younger sequences (Eremenko and Sastri, 1977). Several north-south trending faults and thrusts within the island system and offshore areas are known from surface mapping and seismic surveys. The most extensive is the Jarwa thrust (Roy, 1983) or Eastern Boundary Thrust (GSI, 2000) developed in the main Andaman Island. This easterly dipping Eastern Boundary Thrust is regionally extensive from Myanmar in the north to off Sumatra in south. Further, a set of north-south trending faults slices the sea floor along the eastern edge of the islands in the Nicobar deep and most significant of them being the west Andaman fault (Curray et al. (1979).

The eastern edge of the islands has gentle eastward slope and extends to the floor of the Andaman basin marked by troughs. The depth of the trough varies from 2 km to 3 km below sea level. The north-western margin of the trough is marked by a mosaic of steep and elongate sea-valleys and sea-mounts such as the Nicobar Deep, Barren-Narcondam volcanic islands, Invisible Bank, Alcock and Sewell seamounts (Rodolfo, 1969a,b). The Narcondam is now an extinct volcano but the Barren has erupted recently in early nineties. Principal rock constituents of all the seamounts, which together form the Andaman volcanic arc, are basalt, augite basalt or andesite indicating a possible common origin (Rodolfo, 1969a). Currey et al., (1979) reported that the Andaman back-

arc spreading ridge bisects the central trough and has produced nearly symmetric spreading for the last 11 m.y. with a half-spreading rate of 1.86 cm/year. Average sediment thickness at the Andaman basin is 4 km, but it is delimited eastward by the Mergui Terrace at the Malayan continental margin.

3.0 SITE GEOLOGY

The subsurface information on soil strata has been obtained from various bore holes drilled at different locations of the plant area. The BH-9 and BH-16 and BH-22 drilled up to 25.45m depth at various locations encountered soil strata. In general, the lithology is represented by the loose to medium dense, silty fine sand underlain by dense to very dense, silty fine sand (decomposed sedimentary rock). However, the borehole-11 revealed presence of medium dense silty fine sand as the top layer underlain by dense to very dense silty fine sand (decomposed sedimentary rock), medium dense silty fine sand and dense to very dense silty fine sand (decomposed sedimentary rock). In total, five soil strata are encountered as reported. These are, stratum-I : soft to very soft clayey silt; stratum-II : medium dense silty fine sand; stratum-III : dense to very dense decomposed sedimentary rock; stratum-IV : weathered sedimentary rock; stratum-V : sedimentary rock (shale/siltstone).

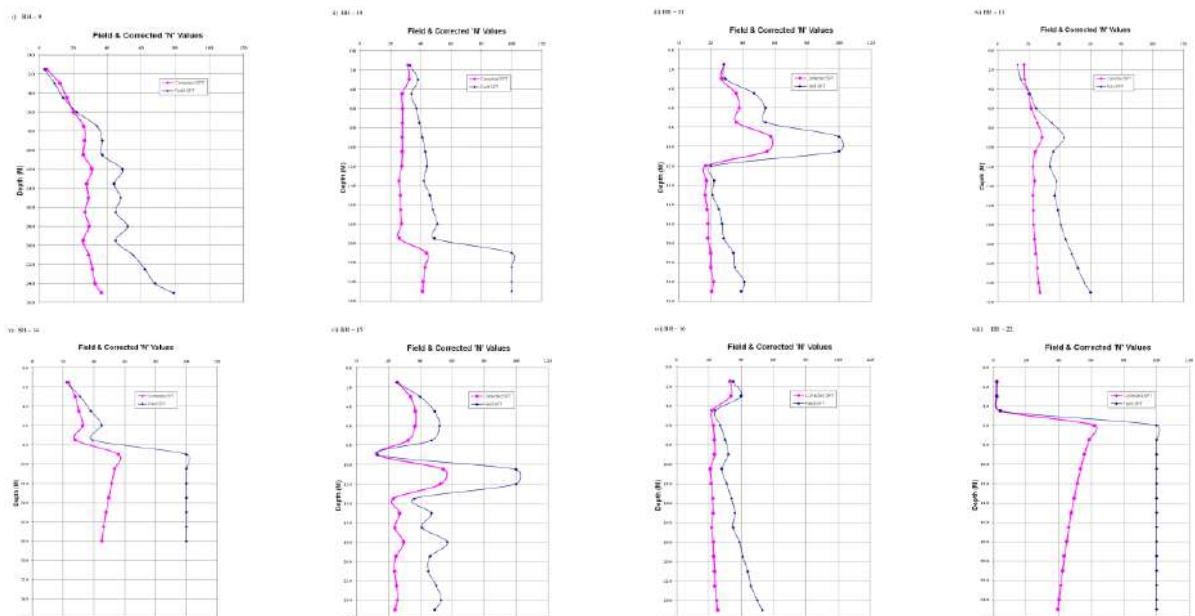


Fig. 2 : Field and Corrected “N” values for the different bore holes.

The average N values using all the data is 28.75 (corrected) and 38.37 (uncorrected). Most of the lithological strata is sandy in nature. Using the existing correlations an

average shear wave velocity of 300 m/s may be conservatively assumed for the site. (BKM should provide an appropriate reference for the correlation used for this.)

4.0 EARTHQUAKE OCCURRENCES

Seismically, the Andaman-Nicobar Island system is very active and focal depth of earthquakes extend up to 150 km. Table 1 shows list of earthquakes that have occurred around the site in a $3^{\circ} \times 4^{\circ}$ area. Epicenters of earthquake around the project site are shown in Fig. 1a and tabulated in Appendix 1. The earthquake activity of the region appears to be associated with the various tectonic features traversing the island system. Banghar (1978) and Verma et al. (1978) reported existence of cluster of epicenters parallel to the Andaman-Nicobar arc. Presence of a NNE-SSW trending back arc seismic zone with a Y-shaped distribution of epicentres has been reported by Mukhopadhyay (1984) and the eastern and western arms of this Y are related to Andaman spreading ridge. It may be noted that there is a significant lack of earthquakes north of 15° N having magnitude more than 5. Sinval et al. (1978) and Chandra (1984) observed lack of intermediate focus earthquakes between 12° and 20° latitudes.

The earthquakes are mostly shallow or of intermediate depths in the region between 3° and 15° N. However, the zone of intermediate depth earthquakes terminates at about 12° , whereas, the zone of shallow seismicity continues further north. The earthquake distribution in the region suggests the existence of at least three different seismic zones characterised by spatial changes in epicentres as well as their focal depths (Rajendran and Gupta, 1989). The earthquakes south of 8° N are associated with the subduction zone under the Sumatra trench, and they are mostly of intermediate focal depth. North of Sumatra trench, at about 8° N, earthquakes occur along two diverging branches. The eastern branch is probably related to the shallow seismic zone under the Andaman spreading ridge. The western branch of shallow and intermediate earthquakes is associated with the Andaman-Nicobar ridge, which passes to the north into a zone of low seismicity. The eastern branch of shallow seismicity continues further north, through Burma towards the Eastern Himalayan syntaxis (Curry et al. 1979) whereas, the western branch passes from the island to continental arc in the Indo-Burman ranges. The 2004 Sumatra earthquake with Mw 9.2 (focal depth 30 km) had a epicentre located at about 440km south of the project site. This giant earthquake also generated devastating tsunami with waves up to 30m effecting Sumatra (Indonesia), Nicobar, Thailand, Sri Lanka and the eastern coast of India. This Sumatra-Andaman undersea

megathrust earthquake was caused by a rupture along the fault between the Buram Plate and the Indian Plate. This event was associated with probably the longest rupture between 1200 to 1300km and caused the entire planet to oscillate. Numerous aftershocks were reported all along the rupture zone in the hours and following days. Massive amount of energy released due to this earthquake generated remarkable seismic ground motions around the globe.

It appears that seismicity pattern of the region is controlled by various tectonic provinces. The Andaman-Nicobar ridge is associated with shallow and a few intermediate earthquakes whereas, the Andaman spreading ridge is characterised by shallow seismicity. Quite a few earthquakes are located around the project site and it is reported that an earthquake of magnitude 7.2 has occurred very close to the project site. Further, towards east of the project site volcanic activity is quite prominent (Aswani et al., 2021, Bandopadhyay, P.C. & Carter, A., 2017, Singha et al., 2019)

5.0 Probabilistic seismic hazard assessment

The methodology used in the present probabilistic seismic hazard analysis (PSHA) can be described in the following four basic steps.

Step 1 Involves the definition of earthquake sources. Sources may range from small faults to large seismotectonic provinces with uniform seismicity.

Step 2 Deals with the seismicity recurrence characteristics of the sources, where each source is described by an earthquake probability distribution, or recurrence relationship. A recurrence relationship indicates the chance of an earthquake of a given size to occur anywhere inside the source during a specified period of time. A maximum or upper bound earthquake is chosen for each source, which represents the maximum event to be considered. Because these earthquakes are assumed to occur anywhere within the earthquake source, distances from all possible locations within that source to the site must be considered.

Step 3 Involves estimation of the earthquake effects in the probabilistic analysis, the range of earthquake sizes are considered and requires a family of earthquake attenuation or ground motion curves, each relating to a ground motion parameter, such as peak acceleration, to distance for an earthquake of a given size.

Step 4 In PSHA the effects of all the earthquakes of different sizes occurring at different locations in different earthquake sources at different probabilities of occurrence are integrated into one curve that shows the probability of exceeding different levels of ground motion level (such as peak acceleration) at the site during a specified period of time. With some assumptions this can be written as:

$$E(Z) = \sum_{i=1}^N \alpha_i \int_{m_o}^{m_a} \int_{r=0}^{m=0} f_i(m) f_r(r) P(Z > z | m, r) dr dm$$

Where, $E(Z)$ is the expected number of exceedances of ground motion level z during a specified time period t , α_i is the mean rate of occurrence of earthquakes between lower and upper bound magnitudes (m_o and m_u), $f_i(m)$ is the probability density distribution of magnitude within the source I , $f_i(r)$ is the probability density distribution of epicentral distance between the various locations within source I and the site for which the hazard is being estimated, and $P(Z > z / m, r)$ is the probability that a given earthquake of magnitude m and epicentral distance r will exceed ground motion level z . The earthquakes are assumed to be Poisson-distributed while carrying out the probabilistic seismic hazard analysis.

5.1 SEISMOGENIC SOURCE ZONES

The first step is to identify and characterize the seismogenic zones. Five seismogenic source zones have been identified for the site specific studies of this site based on the seismicity. The common tectonics of the study area is the north-south trending Andaman Fault occurring closer to the site and the Andaman Trench marking the trace of subduction zone. The seismogenic source zones are shown in Fig. 3.

Seismogenic Zone – I

The project site falls in this zone. The prominent seismogenic source of the zone is the Andaman Fault. Numerous earthquakes have occurred in this zone with a cluster towards northeast of the site. Magnitude of earthquakes range from 2.8 to 7.2 and hypocentral depth range from 1.0 to 300km. Rupture mechanism of the earthquakes are majorly strike slip.

Seismogenic Zone – II

The seismogenic zone-II occurring to the south of the Zone-I also include the Sumatra (Indonesia) region. Numerous earthquakes have occurred in this zone and an earthquake cluster

may be observed towards north of the zone closer to the Andaman Fault. Earthquake occurrences range in magnitude from 2.7 to 7.3 and depth range from 1.0 to 422km. Rupture mechanism of some significant earthquakes indicate majority earthquakes occurred due to reverse faulting mechanism.

Seismogenic Zone – III

In this zone the earthquake occurrences are distributed on the both sides of the Andaman Fault. The magnitude and depth of occurred earthquake range from 2.9 to 6.9 and 8 to 200 km respectively. Fault plane solutions of the earthquake indicate predominant normal slip.

Seismogenic Zone – IV

This zone includes part of the Andaman Trench marking the subduction zone. Many earthquakes with magnitude range from 3.1 to 7.9 occurring at the depths ranging from 9.4 to 115km have occurred in this zone. Focal mechanism of the occurred earthquake indicates reverse slip as the predominant slip mechanism.

Seismogenic Zone – V

As the seismogenic zone-V this zone also includes part of the Andaman Trench. The earthquake occurrence of this zone range in magnitude from 2.8 to 7.5 and the focal depth range is 4.0 to 271km. The predominant fault slip mechanism is the reverse faulting as indicated by the fault plane solutions.

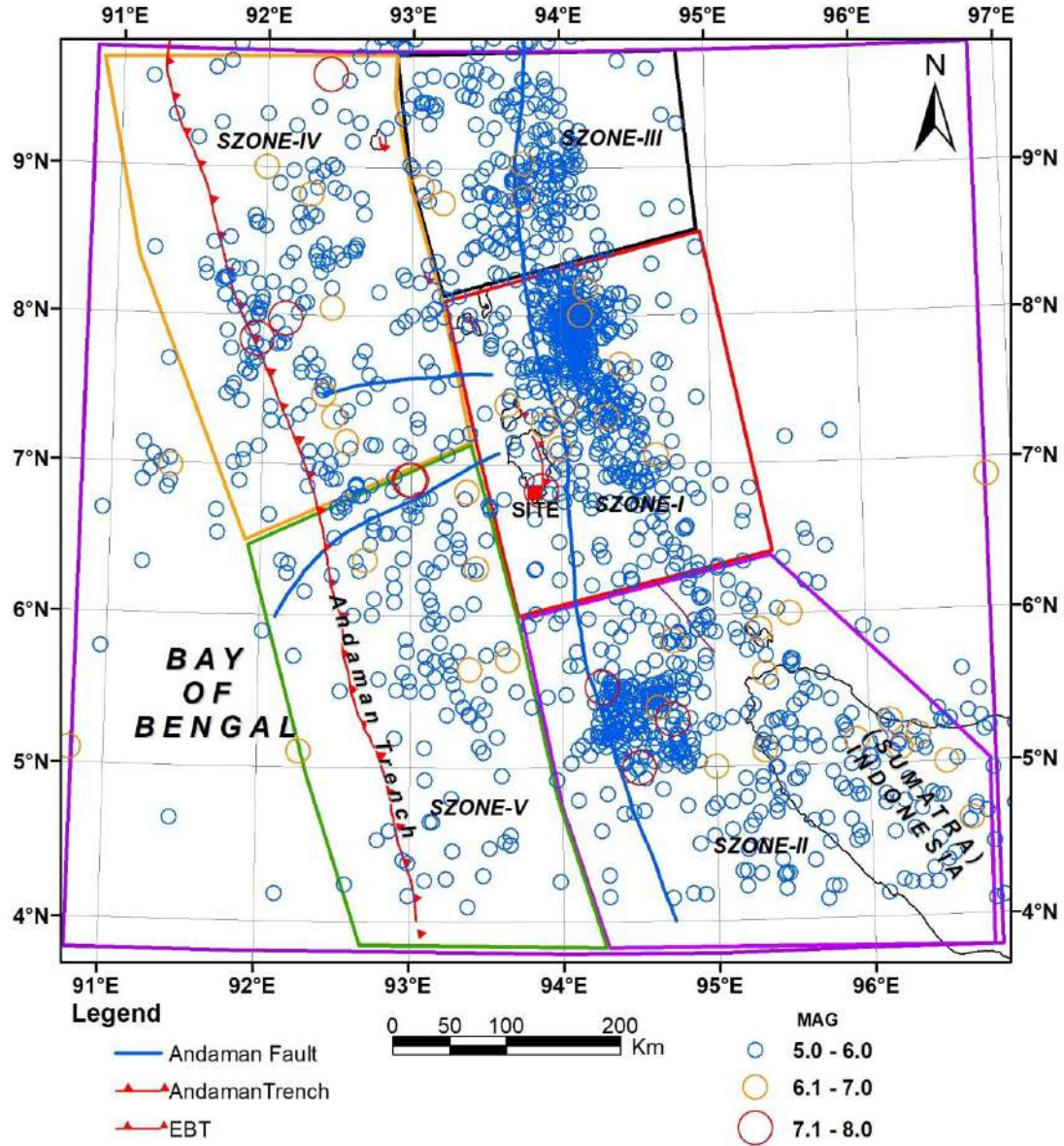


Fig. 3 Seismotectonic set up and seismogenic zones for the Nicobar Gas Plant site. Earthquake occurrences having magnitude 5.0 and above are plotted.

5.2 Seismicity Analysis of the Study Area

The earthquake catalogue as obtained from NCS, New Delhi and ISC has been used in the present study. The data is given in Appendix-I and is plotted in Fig. 1. Since the information on the type of magnitudes in the catalogue and their conversion relationships (to change the scales of the magnitudes) for this region were not available, the magnitudes reported have been considered in their present form for the analysis. To separate the dependent events from the independent events, the earthquake catalogue has been de-clustered. The de-cluster algorithm used is based on Habermann

(1987). However, the historical data has been taken into consideration for assigning maximum magnitude to each source zone. The cut off magnitude has been found using the Goodness-of-fit test (GFT) method given by Wiemer and Wyss (2000). The seismic hazard parameters namely, the seismic activity rates λ and β of Gutenberg Richter relationship have been computed. The a, b values and magnitude of completeness (M_c) are given in Table I.

Table I Seismic hazard parameters for various source zones.

Source	a	b	M_c
Seismogenic Source Zone SZ-I	8.46	1.54 ± 0.19	4.9
Seismogenic Source Zone SZ-II	6.58	1.15 ± 0.17	4.8
Seismogenic Source Zone SZ-III	7.31	1.36 ± 0.11	4.9
Seismogenic Source Zone SZ-IV	5.02	0.92 ± 0.02	4.3
Seismogenic Source Zone SZ-V	4.67	0.89 ± 0.03	4.3

5.3 Ground Motion Prediction Models

It is well known from many earlier studies that the uncertainties in the wave attenuation models contribute significantly to the absolute hazard level and to the total uncertainty in the seismic hazard estimates (e.g., Akkar and Bommer, 2006). The most important factor in this sense is the aleatory uncertainty, since in the hazard computations we integrate directly over the distribution described by the scatter (sigma value) in the ground motion model. Therefore, the scatter is nearly as important as the mean with respect to contribution to the total hazard.

One important factor in the present study is the requirement of spectral attenuation relations, i.e., spectral relations for a suite of frequencies. The selected attenuation relationships have been chosen to represent as closely as possible the tectonic environment (subduction zone) of the earthquake source zones and the site conditions. However, ground motion estimates vary widely depending on the relationships that are chosen to apply in any PSHA and the relationships are recognized as being a dominant source of uncertainty in ground motion estimates. The attenuation relationships used in the present study are given by Parker et al. (2022) and Abrahamson and Gulerce (2022).

Parker, Stewart, Boore, Atkinson and Hassani (2021)

They have developed empirical global Ground Motion Models (GMMs) for predicting peak ground acceleration (PGA), peak ground velocity (PGV), and 5%-damped pseudo-spectral accelerations (PSA) for periods ranging from 0.01 to 10 seconds. These models apply to the median orientation-independent horizontal component (RotD50) of ground motion from both interface and intraslab subduction earthquakes. The GMMs are structured to capture observed differences in source and path effects between interface and intraslab events and are conditioned on moment magnitude (M), rupture distance (Rrup), and hypocentral depth (Zhyp). The reference site condition for the model is a time-averaged shear wave velocity in the upper 30 meters (VS30) of 760 m/s.

The median model functional form is additive in natural log space, producing the natural log of PGA, PSA and PGV .

$$\mu_{lnY} = c_0 + F_P + F_M + F_D + F_S(I)$$

where μ_{lnY} is the natural logarithm of the predicted ground motion intensity measure. c_0 is a constant term that controls the overall amplitude of the predicted ground motion. This constant is a regionalized component. F_P is the path model, describing the decay of ground motion with distance. F_M is the magnitude-scaling model. F_D is the source-depth scaling model. F_S is the site-amplification model. The models also provide definitions for aleatory variability (random variability) and epistemic uncertainty (uncertainty in the median model), which are crucial for seismic hazard analyses. The aleatory variability includes between-event (τ) and within-event (ϕ) components, with within-event variability further partitioned into site-to-site and single-station within-event components for partially non-ergodic applications. Epistemic uncertainty is represented by standard deviations on the regional model constants allowing for scaled-backbone representations in hazard analyses.

The NGA-Sub database, comprising over 71,000 three-component time series from 1883 earthquakes across global subduction zones, was the foundation for model development. Records were selected based on the availability of essential metadata like moment magnitude (M), rupture distance (Rrup), hypocentral depth (Zhyp), and VS30. Strict criteria ensured the inclusion of mainshocks, specific event classifications (interface or intraslab), and recordings within defined distance and depth limits. Furthermore, only events with at least three recordings were used for model development, with a focus on forearc regions and records capturing the P-wave start.

This rigorous selection process resulted in a screened database with interface records from events M5-9.1 and intraslab records from M4.5-8.3, primarily from Japan, South America, and Taiwan.

Abrahamson and Gulerce (2020)

Abrahamson and Gulerce (2020) have developed a set of region-specific Ground Motion Models (GMMs) for subduction zone earthquakes, drawing upon a subset of the PEER NGA-SUB database. These GMMs address both subduction interface and intraslab earthquakes. The GMMs predict 5%-damped spectral acceleration (PSA), representing the median orientation-independent horizontal component (RotD50). The functional form of the median GMM is presented in natural log units as:

$$\ln \text{PSA}(g) = a_1 + a_2 + a_3(M - 7)\ln(R_{\text{rup}} + H_{\text{FF}}(M)) + a_6 R_{\text{rup}} + f_{\text{mag}}(M, F) + f_{\text{ztor}}(Z_{\text{TOR}}) + f_{\text{site}}(\text{PGA}_{1000}, \text{VS}_{30}) + f_{\text{slab}}(R_{\text{rup}}) + f_{\text{basin}}(Z_{2.5}) + F_{\text{AS}}a_{15}.$$

where $\text{PSA}(g)$ is the median 5%-damped spectral acceleration, M is moment magnitude, R_{rup} is rupture distance (km), F is a dummy variable for event type (0 for interface, 1 for intraslab), Z_{TOR} is depth to top of rupture (km), VS_{30} is time-averaged shear-wave velocity over the top 30 m (m/s), PGA_{1000} is the median peak acceleration (g) for $\text{Vs}_{30} = 1000$ m/s, $Z_{2.5}$ is the depth to $\text{Vs} = 2.5$ km/s (m), F_{AS} is a dummy variable (0 for mainshock, 1 for aftershock), $H_{\text{FF}}(M)$ is a finite-fault term. The model is based on a subset of the NGA-SUB database, which originally contained over 70,000 recordings. The selected subset includes 3,914 recordings from 113 interface earthquakes (M5–9.2) and 4,850 recordings from 89 intraslab events (M5–7.8). Data selection involved strict criteria to remove outliers, misclassified events, and recordings with unreliable metadata or late P-triggers. The final subset comprises 8,968 recordings from 202 earthquakes. The global GMM's functional form accommodates differences in magnitude, distance, and depth scaling for interface and intraslab earthquakes. For instance, intraslab events showed stronger magnitude scaling in preliminary regressions. In addition to a global model, region-specific GMMs are developed for seven regions: Alaska, Cascadia, Central America, Japan, New Zealand, South America, and Taiwan. Four region-specific terms are included in the median GMM: large distance (linear R) scaling, linear site amplification scaling ($\ln(\text{Vs}_{30})$), basin depth scaling (for Cascadia and Japan), and the constant term.

5.4 Seismic Hazard Results (PSHA)

The uniform seismic hazard response spectra have been obtained for two conditions i.e., 2% exceedance in 50 years which is equivalent to 2475 years of return period and 10% probability of exceedance in 50 years or 475 years of return period recommendations. The response spectra obtained from the above mentioned three GMPEs were combined with equal weight each. The response spectra obtained for 2475 and 475 years of return period for Maximum Considered Earthquake (MCE) and Design Basis Earthquake (DBE) is shown in Fig. 3a & b. The response spectra have been estimated for the time periods 0.01, 0.02, 0.03, 0.05, 0.075, 0.1, 0.2, 0.25, 0.3, 0.4, 0.5, 0.75, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0 and 6 seconds.

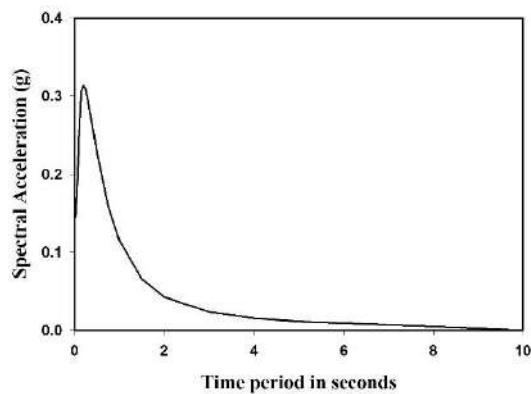


Fig. 4a Response spectra 475 yrs return period

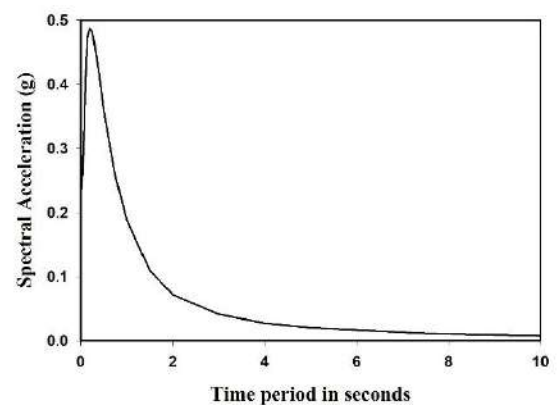


Fig. 4b Response spectra 2475 yrs return period

6.0 DETERMINISTIC ASSESSMENT OF EARTHQUAKE DESIGN PARAMETERS

Definitions

Maximum Considered Earthquake (MCE)

The Maximum Considered Earthquake is defined as the earthquake that can cause the most severe ground motion capable of being produced at the site under the currently known seismotectonic framework around the site. It is a rational and believable event, which can be supported by all known geological and seismological data. It is determined by judgment based on maximum earthquake that a tectonic region can produce considering the geological evidence on past movement and the recorded seismic history of the area.

Design Basis Earthquake (DBE)

The Design Basis Earthquake is defined as that earthquake which can reasonably be expected to occur during the economic life of the structure (say 100 years) and in the

event of exposure to earthquake hazards it will not cause loss of life and the structure will undergo permissible deformations and repairable damage such that the structure, equipment facilities and services will remain functional after the earthquake. As design criteria the resulting ground accelerations at the site under DBE may be taken as a fraction of MCE based on engineering judgment for adopted design methodology.

Estimation of Maximum Considered Earthquake (MCE)

Earthquake Parameters

Based on the regional geology along with the seismotectonics as described in sections 2.0 to 4.0, the parameters for maximum probable earthquakes which can be generated from the nearest potential seismogenic source around the site are given in Table II. The horizontal peak ground acceleration estimates are made using empirical formulae developed by the research workers for various tectonic environments. Attenuation relationships are derived by regression analysis using different distance and magnitude measures. As different relationships provide different estimates of probable ground acceleration therefore, a judicious decision is required for adopting a specific attenuation relationship for a particular site for the purpose of estimating the ground motion. In the present case Parker et al. (2022) and Abarhamson and Gulerce (2022) have been used to predict spectral acceleration and PGA.

The MCE value estimated for horizontal peak ground acceleration (PGA) is 0.519g from deterministic assessment at median level considering the Andaman fault as the closest seismogenic aource (Table II). Shear wave velocity used is 300m/s for soil.

TABLE- II Peak Ground Acceleration from Various Seismogenic Sources for Nicobar Gas Plant, Andaman & Nicobar.

Sources	Mag	Rrup	DHyp	Slab	ZTOR	Vs30	Median
Andaman Fault	8	15.5	26	Interface	0	300	0.519g
Andaman Trench	8	18.31	30	Interface	0	300	0.396g

7.0 GROUND MOTION CHARACTERISTICS

An artificial time history of ground motion (as there are no records of strong ground motion available in the region around the site) has been generated such that its spectra (5% damping) matches the chosen target spectra. The time history of ground motion is shown in Fig. 4 normalised to unit gravity at equal time intervals of 0.01 sec. Fig 5

gives the shape of normalised acceleration spectra for 0.8, 1.0, 1.6, 2, 3, 5, 7 and 10% damping. The following equation can be used to calculate the digital values of normalized acceleration spectral values. Various parameters used in the equation for the different damping values are given in Table- III.

$$S_a = \text{PGA} \times \begin{cases} 1; & 0.00 \leq T \leq 0.030 \\ (T/0.030)^\alpha; & 0.030 \leq T \leq T_1 \\ A; & T_1 \leq T \leq T_2 \\ V/T; & T_2 \leq T \leq T_3 \\ D/T^2; & T \geq T_3 \end{cases}$$

The values of $\alpha, A, V, T_1, T_2, T_3$ and D are given in the following Table

Table III - Equations for response spectra (Median) (normalised to 1 'g') for various values of percentage of damping for Nicobar Gas Plant project site.

Damping %	α	T_1 (s)	A	T_2 (s)	V (s)	T_3 (s)	D (s ²)
0.800	1.547	0.090	5.470	0.360	1.969	1.800	3.545
1.000	1.527	0.090	5.350	0.360	1.926	1.800	3.467
1.600	1.219	0.096	4.130	0.380	1.569	1.900	2.982
2.000	1.089	0.096	3.550	0.380	1.349	1.900	2.563
3.000	0.887	0.100	2.910	0.400	1.164	2.100	2.561
5.000	0.727	0.100	2.400	0.400	0.960	2.100	2.112
7.000	0.576	0.100	2.000	0.400	0.800	2.100	1.760
10.000	0.465	0.100	1.750	0.400	0.700	2.100	1.540

8.0 SEISMIC DESIGN CRITERIA

The “Criteria for Earthquake Resistant Design of Structures and Equipment” is recommended as follows:

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1):2016 and IS:1893 (Part 4):2015.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at Figure-5 in IS:1893 (Part 1) and Annexure B of IS:1893 (Part 4). However appropriate importance factor (I) and response reduction factor (R) should be used in accordance with IS:1893 (Part 1 and Part 4).

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall be adopted as provided in Table 5 of IS-1983-Part 4: 2015

Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontals and one vertical) components of earthquake motion.

9.0 RECOMMENDATIONS

Deterministic seismic hazard assessment provides estimated peak horizontal ground acceleration (PGA) as 0.519g for the maximum considered earthquake (MCE) at median level considering these earthquake parameters. Whereas, probabilistic seismic hazard assessment for this site provides, PGA of 0.149g for DBE (475 year return period) and PGA of 0.241g for MCE (2475 year return period).

In view of this, it is recommended to adopt the deterministic estimate of DBE PGA as 0.26 g for use in the design of facility.

The design spectrum for horizontal component of the DBE and MCE level event is obtained by multiplying the spectral shape given in Table 1 by the respective PGA values.

The design basis earthquake (DBE) spectrum is obtained from the maximum considered earthquake horizontal spectrum by multiplying with a factor of 0.50.

The vertical spectrum value for a period is obtained by multiplying by $\frac{2}{3}$ to the corresponding horizontal spectral acceleration value at that point. These spectra are obtained from the shape of normalized design spectrum by using specified factors.

+

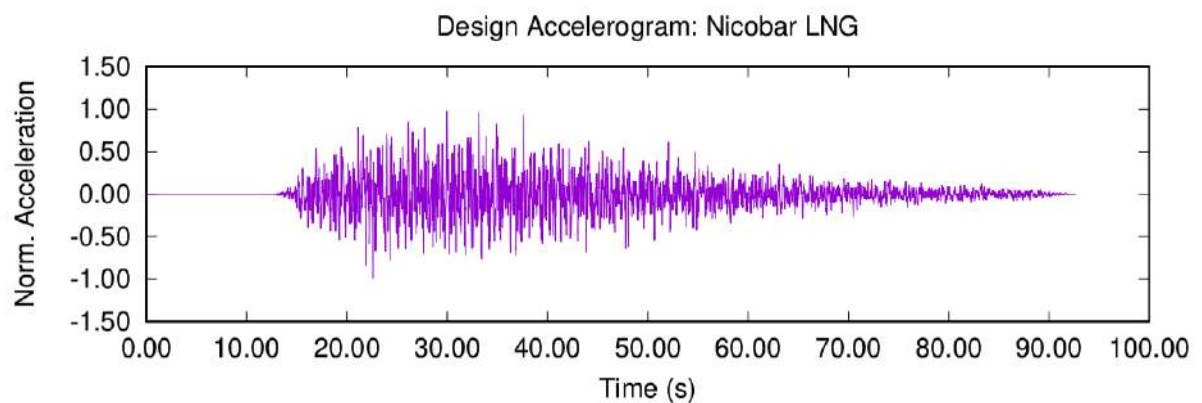


Fig. 5 Design Accelerogram : Nicobar Gas Plant

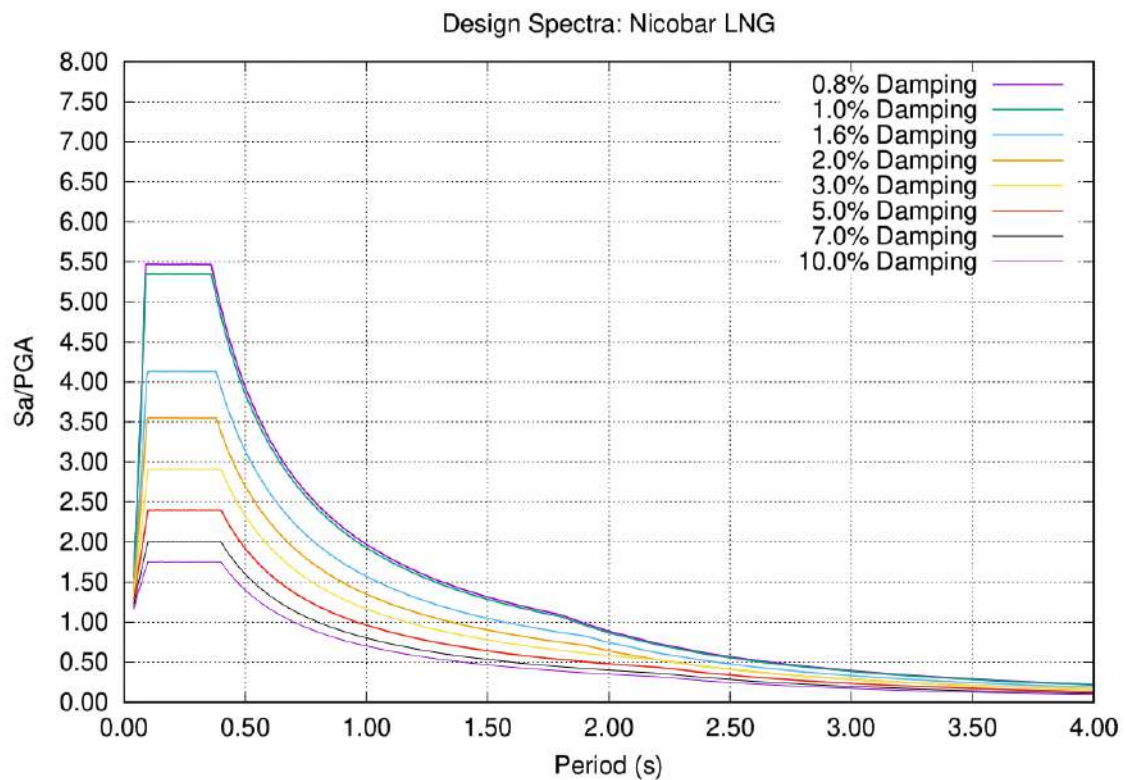


Fig. 6 Design response spectrum shape : Nicobar Gas Plant

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D-1-9

**ANNEXURE-F
QUALITY REQUIREMENT**

CLAUSE NO.	<div>TECHNICAL REQUIREMENTS</div> <div>  </div>		
D-1-9	<div>Annexure- F</div> <div>QA REQUIREMENT</div> <p>All Civil, Structural and Architectural construction work at the project shall be executed strictly in accordance with the Quality Assurance guidelines specified in separate part of the Specification.</p>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART B BID DOC NO: CS-6401-001-2	SUB-SECTION-D-1-9(F) CIVIL WORKS QA REQUIREMENT	PAGE 1 OF 1

D-1-9

ANNEXURE-H

AREA DRAINAGE STUDY REPORT

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW GAS BASED POWER PLANT
CLIENT	FICHTNER CONSULTING ENGINEERS (INDIA) PVT. LTD.
DOCUMENT NO.	GPPL/ FCEIPL/ADS/2025-26/R-01
DATE	June, 2025

Report on
AREA DRAINAGE STUDY FOR A PROPOSED 108 MW GAS BASED
POWER PLANT IN GREAT NICOBAR ISLAND, INDIA

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5.2 Recommendations

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1.0 Introduction & Objective

1.1 General

NTPC Limited (A Government of India Enterprise) is contemplating to set-up power infrastructure in multiple phases with LNG based Gas Engine, PV Solar and Transmission System at Great Nicobar Island as per the mandate from MoP under the plan for Holistic Development of Great Nicobar Island. M/s Fichtner Consulting Engineers (India) Pvt. Ltd. has been emerged as owner's consultant for preparation of Detailed Project Report (DPR) for the said project. M/s Fichtner has selected M/s Geosolution Proservices Pvt. Ltd. (GPPL) for conducting field studies pertaining to DPR preparation. This report has been prepared for partial fulfillment of field studies for DPR preparation.

1.2 Location

Great Nicobar Island is the southernmost and largest island of the Nicobar Islands group, which is part of the Andaman and Nicobar Islands, a union territory of India. It lies in the Bay of Bengal, approximately 150 km north of Sumatra, Indonesia. The island's coordinates are roughly 6.8° N latitude and 93.8° E longitude. Notably, Indira Point, located on Great Nicobar, is the southernmost point of India.

The project site is located in the southern part of the Great Nicobar Island, the coordinate is 6.828392° N, 93.844112° E. The project site is located in and around Galathea Bay.

The site can be accessed by a metalled road from Campbell Bay. Campbell Bay is connected to Port Blair through Ship and Helicopter Services.

1.3 Purpose and Scope of This Study

NTPC is planning to set up 108MW LNG based engine power plant at Great Nicobar Island (GNI). As a part of preparation of Detailed Project Report (DPR), Area drainage study needs to be carried out.

Area drainage study has been carried out for the identified project area (approx. 100 Acres) along with the drainage pattern of external surrounding area. The study is required majorly for development of plant area drainage and to finalize the safe grade elevation for the plant.



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Scope of Work

The following tasks were undertaken and successfully completed as part of the stormwater drainage planning and flood assessment study for the proposed power plant and its adjoining area:

- i. **Study of Existing Drainage System:** Conducted a detailed study of the existing natural drainage patterns and systems using available reports, literature, satellite imagery, and other relevant information. The study also included a thorough review of the topographical features of the proposed power project site and the surrounding region.
- ii. **Rainfall Data Analysis:** Reviewed and analyzed historical and recent rainfall data to develop appropriate design storm scenarios suitable for the site.
- iii. **Topographic and Imagery Review:** Analyzed Survey of India (SOI) maps, topographic survey data, and high-resolution satellite imagery to support drainage design and hydrologic modeling.
- iv. **Flood Hydrograph Estimation:** Estimated flood hydrographs using both historical records and design rainfall events. Based on this, a complete stormwater drainage scheme was developed for the project site and its surroundings, including recommendations for the diversion of existing nallas and streams, if required.
- v. **Design Flood Routing and Safe Grade Elevation:** Routed the design flood hydrograph through the relevant drainage systems under both pre-project and post-project boundary conditions. This analysis facilitated the recommendation of a Safe Grade Elevation for the plant infrastructure.
- vi. **Stormwater Disposal:** Identified and recommended appropriate final disposal points for stormwater and plant drainage to ensure effective drainage management.
- vii. **Assessment of Tsunami and Cyclone Impact:** Assessed the potential impact of tsunamis and cyclonic events on the plant area and proposed necessary mitigation measures to ensure the safety and functionality of the facility.
- viii. **Construction Stage Flood Mitigation:** Proposed interim measures to prevent flooding and waterlogging during the construction phase of the project.
- ix. **Finalization of Safe Grade Elevation:** Determined and finalized the safe grade elevation of the plant site with respect to Mean Sea Level (MSL), considering hydrological, topographical, and meteorological parameters.



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2.0 EXISTING SITE CONDITION

2.1 Topography

Great Nicobar Island covers an area of approximately 921 square kilometers. The island is characterized by undulating hills that predominantly follow a north–south orientation. According to the Land Use and Land Cover map of India, Great Nicobar Island falls under the category of 'Evergreen/Semi-evergreen Woodland' (Fig. 1).

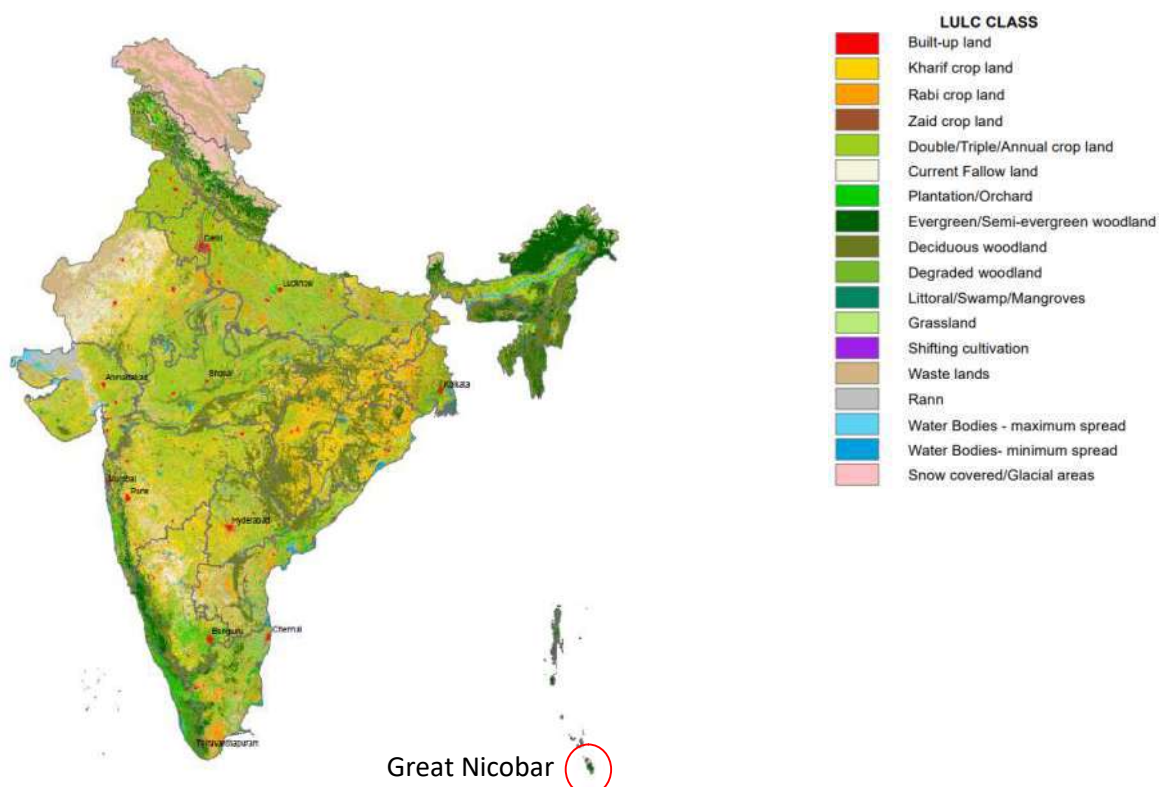


Fig.1 Satellite derived Landuse / Landcover Map (2021-22) at 1: 250,000 scale (Source : Digitally classified LULC map generated under NR Census project- Land Use Land Cover Mapping using Multitemporal AWiFS Data www.bhuvan.nrsc.gov.in)

As part of the study, a field topographic survey was conducted, supplemented by data collected from online sources and published literature. Topographic information provided by the Survey of India (SOI) was also reviewed for the study area. The relevant topographic maps are presented in Fig. 2(a) and 2(b). As per the figures, Great Nicobar Island as a whole exhibits a predominantly hilly and undulating topography, with elevations generally aligned along a north–south direction. The terrain is characterized by a series of ridges and valleys, with Mount Thullier, the island's highest point, reaching an elevation of 642 meters above sea level. The



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coastal areas are relatively narrow and flat compared to the rugged, steeper interior regions. Inland, the landscape features dense evergreen and semi-evergreen forests, shaped by steep slopes and varied elevations. The island's overall topography reflects significant geological and geomorphological diversity, largely influenced by tectonic activity and coastal processes. Compared to the island's central highlands, the project study area represents a relatively low-lying zone. Based on the analysis of satellite data and field observations, the maximum elevation within the project site is found to be less than 100 meters above sea level.

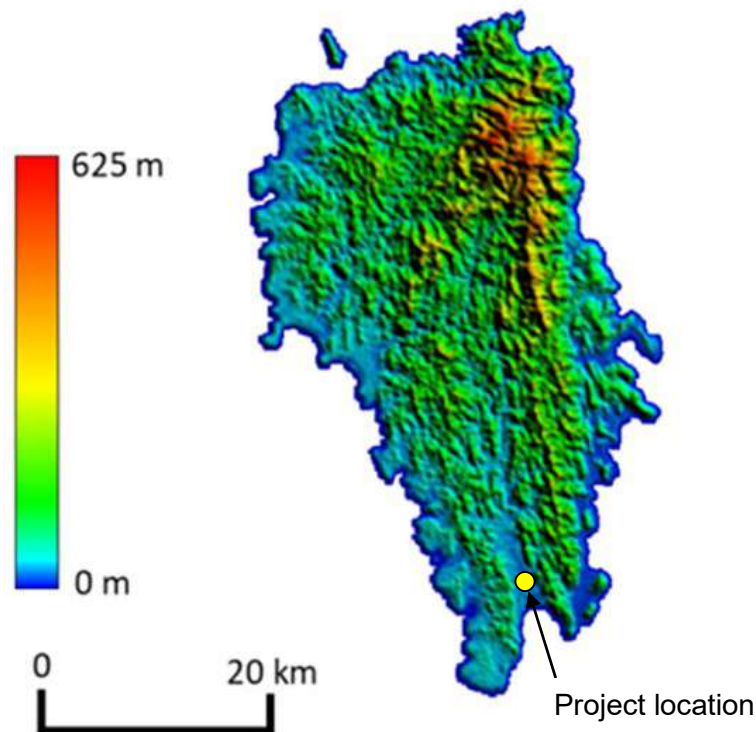


Fig. 2 (a) Topography map (Source: <https://doi.org/10.1144/qjegh2024-063>).



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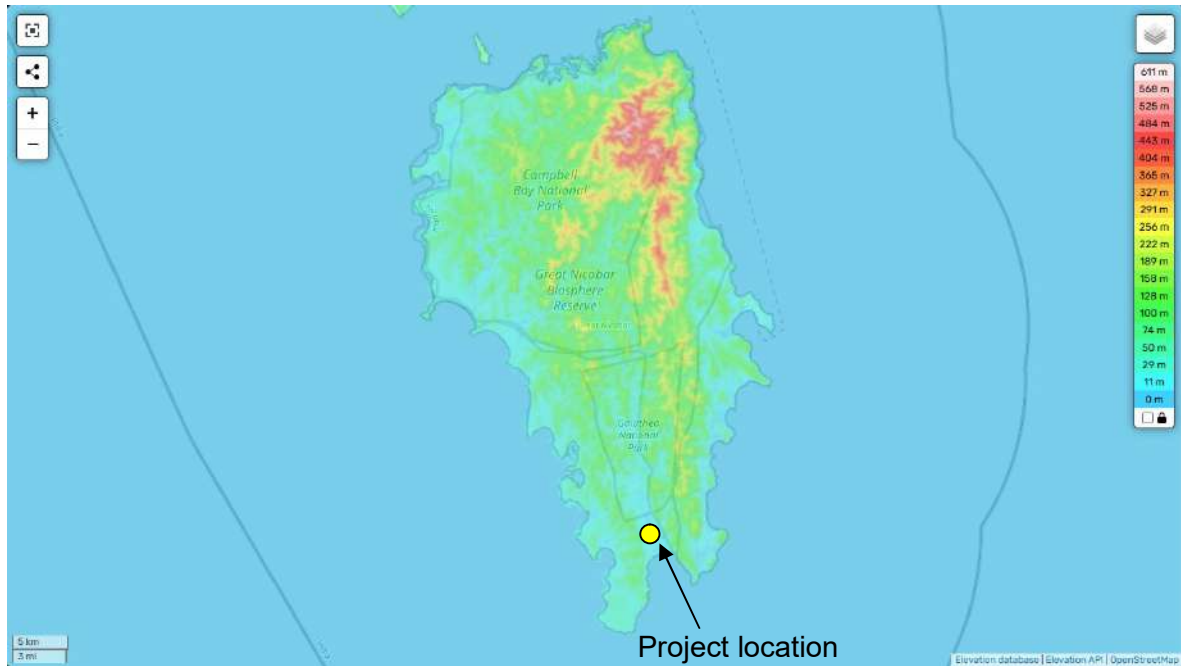


Fig. 2 (b) Topography map (Source: <https://en-gb.topographic-map.com/map-vfmb51/Great-Nicobar-Island/?center=6.92166%2C93.93997&zoom=11&popup=7.02525%2C93.90358>).



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The field topographic survey data also shows similar results (Fig. 3), with the highest elevation within the project area recorded at 65 m and the lowest point at 4.5 m.

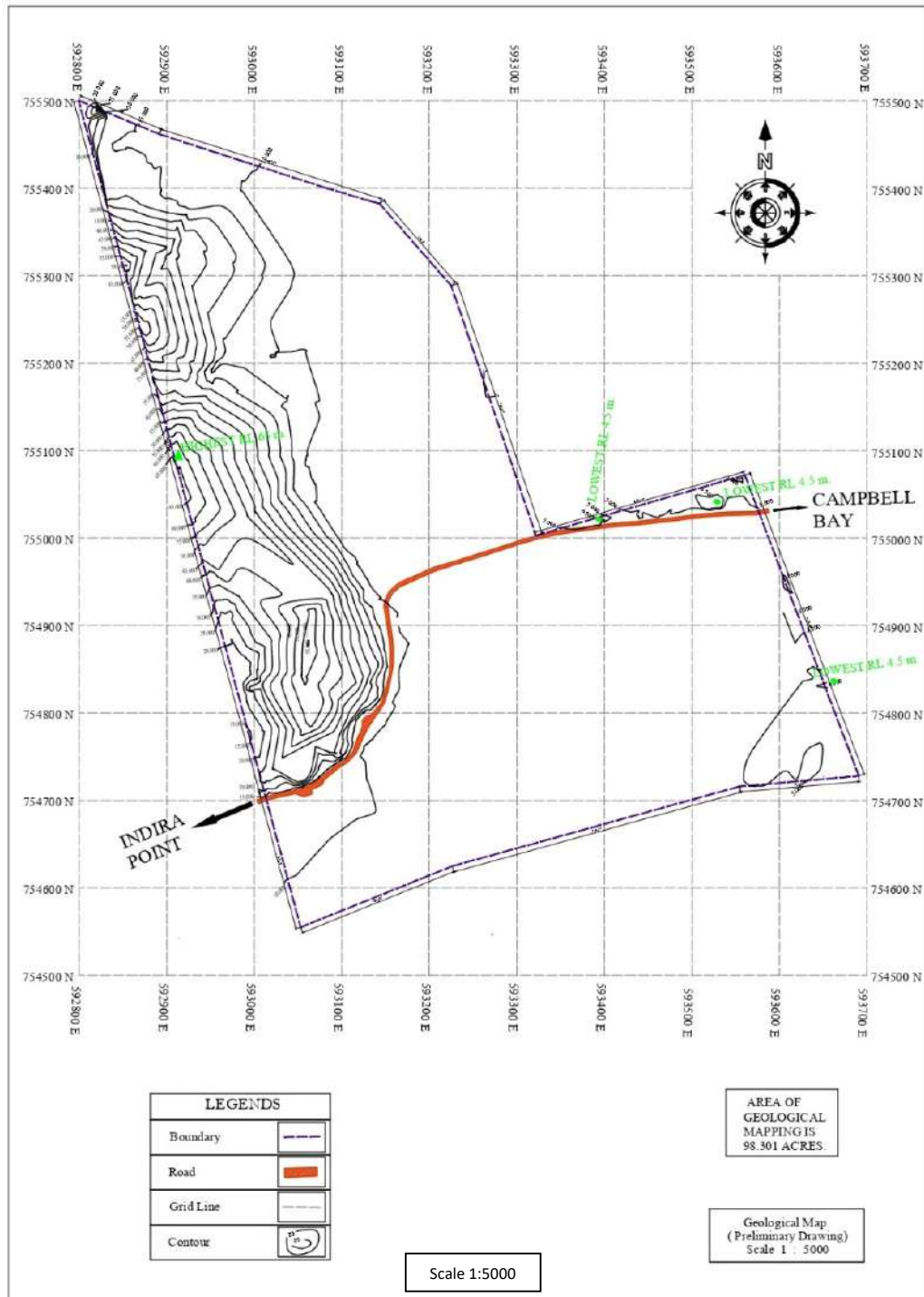


Fig. 3 Contour map for the project area.



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2.2 Geology

Geologically, Great Nicobar Island is part of an island arc formed by the collision of the Indo-Australian Plate with the Eurasian Plate. This tectonic activity has given rise to a series of highlands and islands, including the Andaman and Nicobar Islands. The island features mountainous terrain, with elevations reaching up to approximately 650 meters above sea level.

2.3 Soil type

The soils of Great Nicobar Island primarily consist of loam and sandy loam. These soils have developed under the influence of vegetation and climate, and are found on diverse parent materials like fragmented granites, marine sediments, and outwash in the valley floors. Upland areas tend to be shallow and gravelly, while valley floors have medium to heavy textured soils, suitable for agriculture. The infiltration rate of the soil is very high.

2.4 Climate & Ecology

The island experiences a warm, tropical climate with significant rainfall due to annual monsoons. Its diverse ecosystems include tropical evergreen forests, coastal mangroves, and inland grasslands. Great Nicobar is home to over 1,800 species of flora and fauna, many of which are endemic. The island hosts two national parks Campbell Bay and Galathea and was designated a UNESCO Biosphere Reserve in 2013.

2.5 Natural Drainage Pattern

The island exhibits a predominantly radial to dendritic drainage pattern, largely influenced by the central highlands. Numerous small to medium-sized rivers originate from the interior hills and flow toward the coastal plains, eventually discharging into the Bay of Bengal or the Indian Ocean. Key rivers such as the Alexandra, Amrit Kaur, Dogmar, and Galathea play a significant role in draining the island's undulating terrain (Fig. 4). These rivers generally flow southward, in alignment with the island's topographical gradient. Galathea River is the most important river on Great Nicobar Island. Flowing southward, it discharges into Galathea Bay, near the island's southernmost tip at Indira Point. The Galathea River



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drains a large catchment area in the central and southern parts of the island, including the designated project site.



Fig. 4 Drainage map of Grater Nicobar. (Source: <https://www.alamy.com/vector-map-of-the-east-indian-island-of-great-nicobar-image558395450.html?imageid=AF42AA65-F6BB-41FCB29D7EFBB44E86F1&p=294872&pn=1&searchId=9eee50cfc841b5c6b4645eef10af68f6&searchtype=0>).

2.6 Existing Drainage Pattern

The project area covers approximately 98.3 acres and can be broadly divided into two main regions: hillock and plain land. The hillock region occupies about 29.155 acres, while the plain land spans approximately 69.145 acres. The majority of the site is densely covered by rainforest, with a paved road running through the center of the project area. Two main types of drainage paths have been identified within the site. In the hilly region, pucca side drains with steep gradients are present, whereas in the plain land, kacha side drains with relatively gentle slopes run along both sides of the road. These drainage systems are properly connected to the Galathea River, which flows southward and ultimately discharges into Galathea Bay (Fig. 5).



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Fig. 5 Drainage pattern inside the project area with the nearby locations.

The drainage pattern within the project area is illustrated in Fig. 6 (a), which clearly depicts the sources, elevations, and lengths of the existing drainage channels. And the Swampy land portion is given in Fig. 6 (b).



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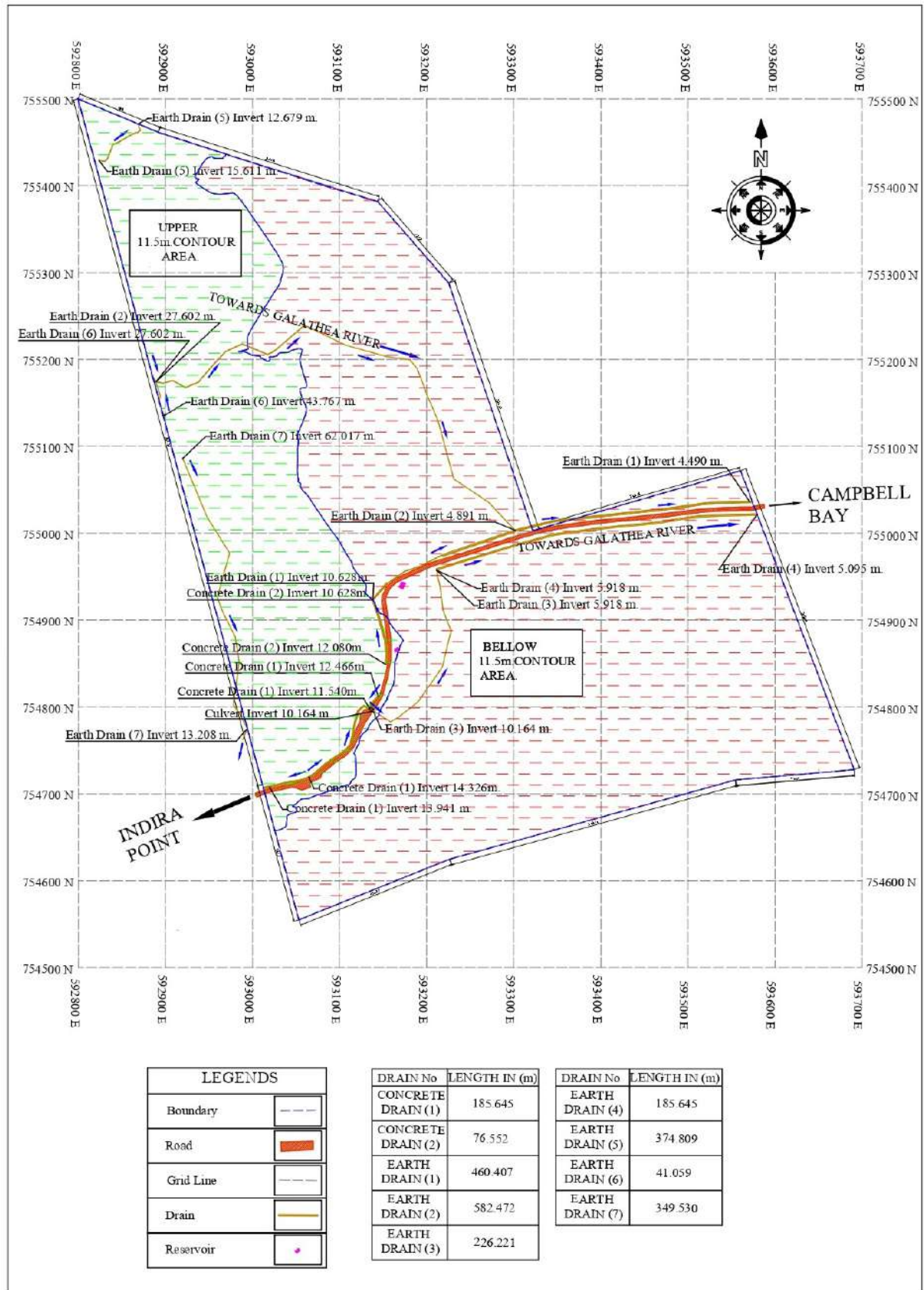


Fig. 6 (a) Drainage pattern inside the project area.



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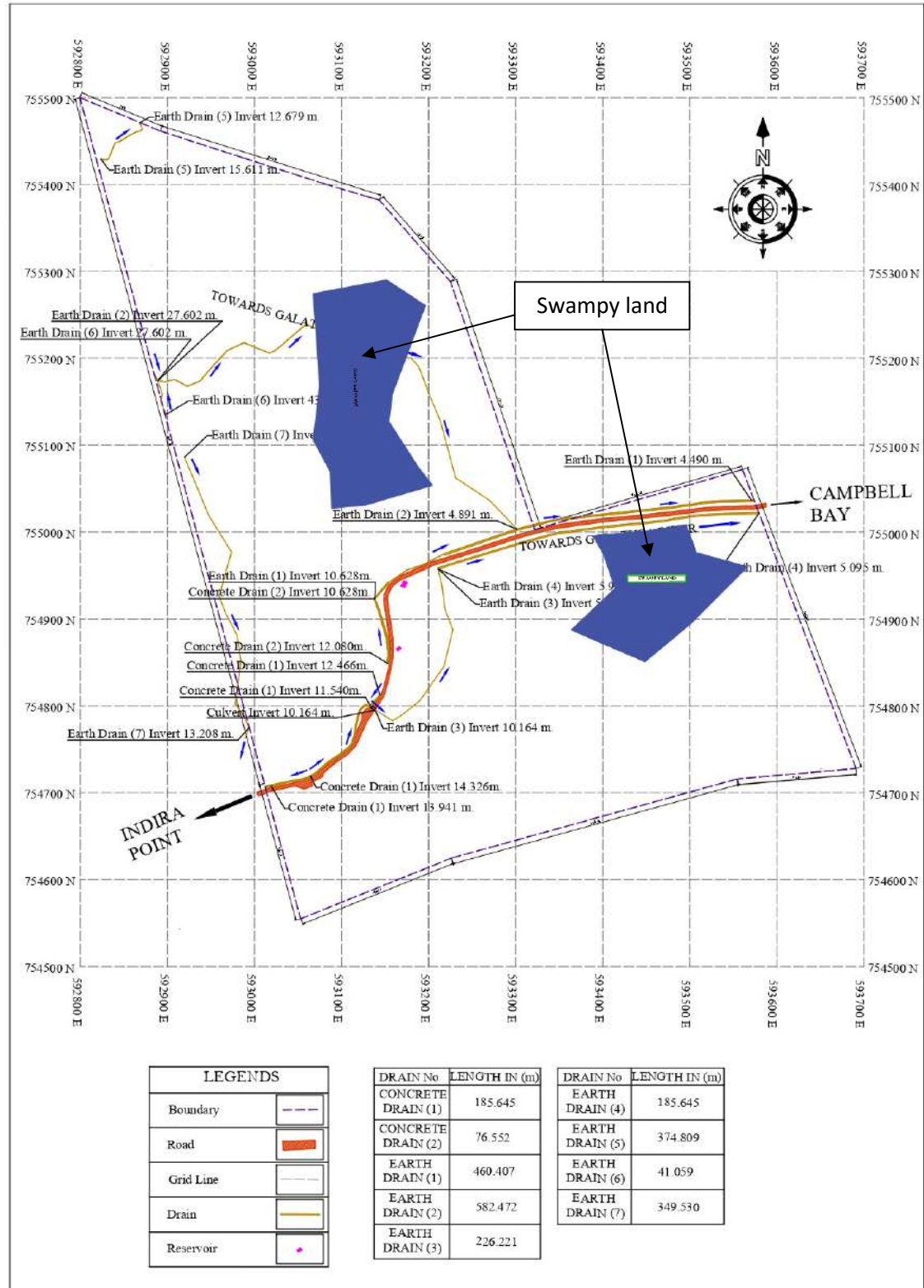


Fig. 6 (b) Swampy land inside the project area.



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3.0 Hydrological Analysis

3.1 Rainfall Data

Great Nicobar Island, situated at the southernmost tip of the Andaman and Nicobar archipelago, experiences a tropical monsoon climate characterized by substantial rainfall throughout the year. The island receives an average annual rainfall ranging from 3,000 to 3,500 mm, with the majority occurring between May and December during the southwest and northeast monsoon seasons. Between 1949 and 2019, Port Blair recorded a mean annual rainfall of approximately 3,079 mm, with a standard deviation of ± 487 mm, reflecting significant interannual variation. In recent years, notable rainfall events have been documented. For instance, in August 2019, Port Blair recorded 797.4 mm of rainfall, surpassing a decade-old record for that month. Additionally, during the 2016 North Indian Ocean cyclone season, Cyclone Vardah brought heavy rainfall to the Andaman and Nicobar Islands, with Port Blair recording 167 mm in a single day. Long-term trend analyses suggest a non-significant decrease in total annual rainfall at a rate of 0.195 mm per year. Moreover, the number of rainy days has shown a slight decline, with an average of 150 rainy days per year historically, reducing to 143 days in the decade from 2010 to 2019. The climate data of Andaman and Nicobar Island from 1949 to 2024 is shown in table 1(Annexure).

The annual rainfall data from 1949 to 2024 is presented in Fig. 7. The data shows that the highest recorded annual rainfall occurred in 1961, measuring approximately 4362.4 mm, while the lowest was 1950.3 mm in 1979. Over the past 25 years, the maximum recorded rainfall was 3771.6 mm, observed in 2011. In the last five years, the highest annual rainfall was 3461.0 mm, recorded in 2021.



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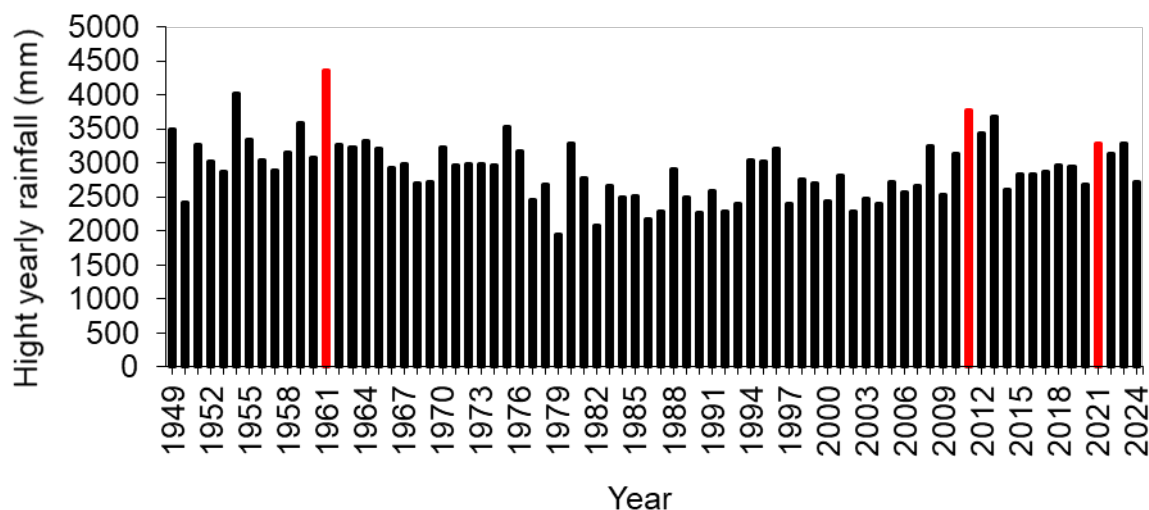


Fig. 7 Annual rainfall data (Source: <http://andssw1.and.nic.in/ecostat/2010/metrologicalstatistics2010.pdf> and <http://andssw1.and.nic.in/ecostat/2008/Meteorological/Temperature.pdf>).

The month-wise rainfall pattern at Nicobar follows a tropical monsoon climate, characterized by significant seasonal variation. The southwest monsoon, active from May to September, contributes the majority of the annual rainfall, with peak precipitation typically occurring between June and August. During these months, average monthly rainfall often exceeds 400 mm. October and November, influenced by the retreating northeast monsoon, also record substantial rainfall, though generally less intense than the peak monsoon months. From December to April, rainfall significantly decreases, with January and February typically recording the lowest monthly totals, often below 100 mm. Monthly rainfall data (2015 – 2024) is shown in table 2 (Annexure).

3.1.1 Analysis of Daily Rainfall Intensity

Methodology

An attempt was made to obtain daily rainfall data specific to Great Nicobar from local government departments and online databases. However, no such data for the project location was available for the past several years. Because of this, daily rainfall data for this project site was collected from available online source (<https://chrsdata.eng.uci.edu/>).

After collection of data, the following steps were followed:

Step 1: At first, the daily rainfall data is checked for missing data and other issues and based on that final data is selected to be analyzed further.

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Step 2: Preparation of annual maximum data series: For each year, the maximum daily rainfall was calculated. The rainfall data is given below:

Table 3: Annual maximum daily rainfall at Port Blair Station (2005 – 2024) (Source: <https://chrsdata.eng.uci.edu/>)

Year	Annual maximum daily rainfall (mm)
2005	83
2006	94
2007	111
2008	81
2009	87
2010	73
2011	133
2012	113
2013	212
2014	120
2015	87
2016	94
2017	225
2018	97
2019	272
2020	85
2021	89
2022	128
2023	249
2024	192

Step 3: Fitting the probability distribution: Extreme Value Distribution – Type I (Gumbel) was used in this analysis. Extreme Value type I (Gumbel) distribution is one of the widely used probability distribution to estimate design rainfall depths for different return periods. There are two ways of determining the rainfall depths:

(i) Using frequency factors

or

(ii) Using the CDF of the distribution (by inverting the CDF). In this study, the frequency method was used as the length of rainfall data available is short; hence there is a possibility that the parameters of the CDF may not be estimated accurately.

While Using frequency factors, the precipitation depths (R_{24}^T) is calculated for a given return period, T is calculated as:



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$$R_{24}^T = \mu_x + S \times K_T \quad \dots\dots\dots (1)$$

Where, μ_x is mean of the data, S is the standard deviation and K_T is the frequency factor. K_T values are calculated for different return periods using the following equation.

$$K_T = -\frac{\sqrt{6}}{\pi} \left\{ 0.5772 + \ln \left[\ln \left(\frac{T}{T-1} \right) \right] \right\} \quad \dots\dots\dots (2)$$

The value of K_T for different return period is given in following Table 1.

Table 4: Values of K_T at different return period

T (Years)	2	5	10	25	50	100
K_T	0.164	0.719	1.305	2.045	2.592	3.137

The precipitation depths calculated from the annual exceedance series was adjusted to match the depths derived from annual maximum series by multiplying a factor of 0.88, 0.96 and 0.99 for 2, 5 and 10 years return period rainfall data respectively. No adjustment of the estimates is required for longer return periods (>10 years return period). In order to consider the climate change effects, the calculated intensity is amplified by 5% to 15% depending on the return period (Kothyari and Garde, 1992).

Estimation of the parameter, i_t^T (Rainfall Intensity)

As the rainfall data finer than 1 day was not available, to get the rainfall intensity of durations other than daily, empirical IDF curve equations was used. There are different IDF curve developed for Indian Scenario (Mujumdar, 2010). Out of different methods, the method developed by Kothyari and Garde, 1992 is very popular (Zope et al, 2016). Kothyari and Garde (1992) developed a formula to derive IDF relationship for India by analyzing the rainfall data from 78 rain gauge stations across India. The generalized relationship with realistic estimates of rainfall proposed by them for various zones of India is

$$i_t^T = c \frac{T^{0.20}}{t^{0.71}} (R_{24}^T)^{0.33} \quad \dots\dots\dots (3)$$



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Where, i_t^T rainfall intensity in mm/h; T return period in years and t duration of rainfall in h, R_{24}^T is 24 hr, T year return period rainfall in mm. c is a constant depends on different Geographical Regions of India.

Rainfall Intensity calculation

The computation of rainfall intensity at various return period was performed in MATLAB version 2021b. The Daily rainfall data collected for the period of 2005 to 2024. The computed annual maximum rainfall series is given in Table 3. The final annual maximum daily rainfall time series analyzed statistically is given in the Table 5.

Table 5: Annual maximum daily rainfall time series (2005 – 2024)

Annual maximum daily rainfall (mm)					
83	94	111	81	87	73
133	113	212	120	87	94
225	97	272	85	89	128
249	192				

The various statistical parameters of the rainfall time series are calculated and shown in Table 6.

Table 6: statistics of annual maximum daily rainfall at project site

Station	Port Blair
Mean (μ_x) mm	131.25
Standard deviation (S) mm	62.24
Maximum, mm	272.00
Minimum, mm	73.00

The Calculated daily rainfall depth at different return period are shown below in Table 7 and Table 8 (Equation 1).

Table 7: Estimated daily rainfall depth without climate change consideration (mm)

T (Years)	2	5	10	25	50	100
Estimated daily rainfall depth (mm)	141.46	176.00	212.47	258.53	292.58	326.50

Table 8: Estimated daily rainfall depth with climate change consideration (mm) (the calculated intensity is amplified by 15%)

T (Years)	2	5	10	25	50	100
Estimated daily rainfall depth (mm)	162.68	202.40	244.34	297.31	336.46	375.47

Next, one example is shown to explain how to use the information at Table 6 and 7 to calculate the Design rainfall intensity for calculating peak runoff to design storm



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water drains. For that purpose, design rainfall intensity, i_t^T , needs to be calculated.

That's why; It is essential to fix the design return period of rainfall. As per CPHEEO manual for power station, recommended design return period is generally 50 years for other cities (population density less than 1 Lakh) and 100 years for class 1 cities (population density 1 Lakh and above). Suppose, $T = 50$ years. Here, the equation (1) and Daily Rainfall of 50 years return period from either Table 7 or Table 8 was used to calculate the design rainfall intensity (i_t^T) for the sub-catchment. One sample calculation is shown in the Table 9. In equation (3), c was taken as 7.1(Kothyari and Garde, 1992).

Table 9: Sample Calculation design rainfall intensity with considering the effect of climate (i_t^T) for 50 years return period

t (hr)	T (year)	R_{24}^T (mm)	c	i_t^T (mm/hr)
0.25	50	327.930	7.1	283.40
0.50	50	327.930	7.1	173.25
1.00	50	327.930	7.1	105.91
2.00	50	327.930	7.1	64.75
4.00	50	327.930	7.1	39.58
8.00	50	327.930	7.1	24.20
12.00	50	327.930	7.1	18.14
24.00	50	327.930	7.1	11.09

Similar way for 100 years return period the rainfall intensity is shown in table below:

Table 10: Sample Calculation design rainfall intensity with considering the effect of climate (i_t^T) for 100 years return period

t (hr)	T (year)	R_{24}^T (mm)	c	i_t^T (mm/hr)
0.25	100	365.106	7.1	337.54
0.50	100	365.106	7.1	206.35
1.00	100	365.106	7.1	126.14
2.00	100	365.106	7.1	77.11
4.00	100	365.106	7.1	47.14
8.00	100	365.106	7.1	28.82
12.00	100	365.106	7.1	21.61
24.00	100	365.106	7.1	13.21

Intensity Duration Frequency (IDF) Curve:

An IDF curve illustrates the relationship between rainfall intensity, storm duration, and frequency (or return period). It is a key tool in hydrological and civil engineering design, used to estimate rainfall events for infrastructure planning. The curve helps



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determine the expected intensity of rainfall for a given duration and return period, aiding in the design of effective drainage and flood control systems. The IDF curves for the project site are shown in Fig. 8 (a) and Fig. 8 (b).

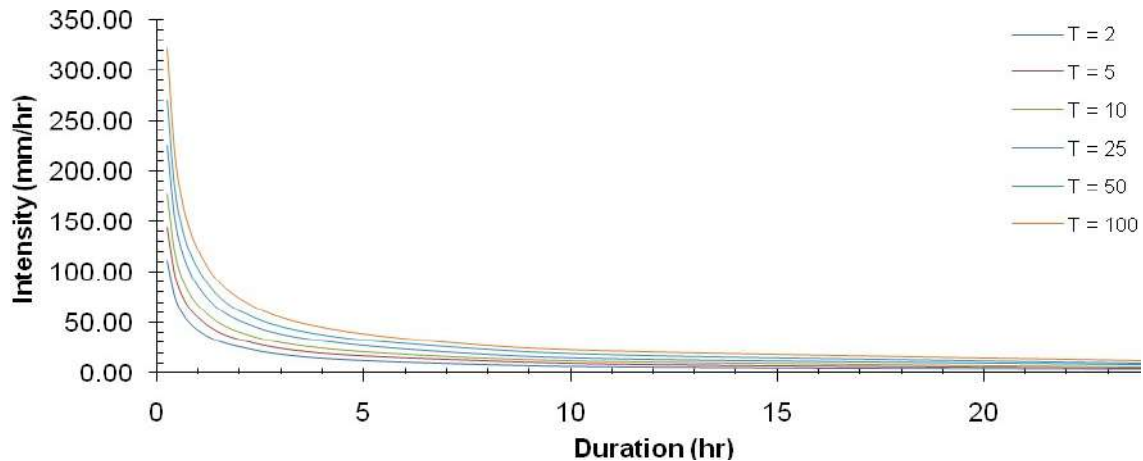


Fig. 8 (a) IDF curve without considering the weather effect.

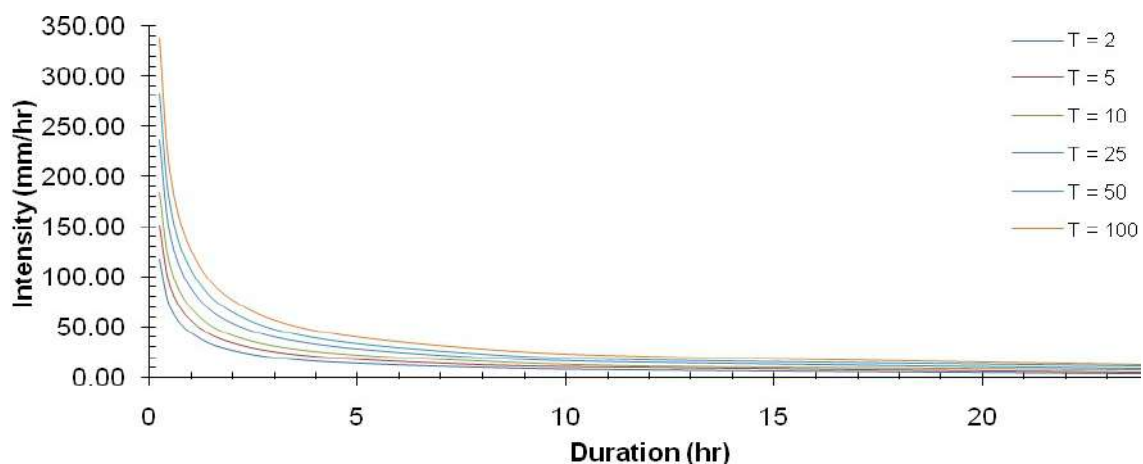


Fig. 8 (a) IDF curve with considering the weather effect.

The values of rainfall intensity at different time period are also shown in table 11 and 12.

Table 11: Intensity without considering the effect of climate

Time (t)	Intensity (mm/hr)					
	T = 2	T = 5	T = 10	T = 25	T = 50	T = 100
0.25	111.85	144.39	176.49	226.17	270.63	322.33
0.5	68.38	88.27	107.89	138.26	165.44	197.05
1	41.80	53.96	65.96	84.52	101.14	120.46
2	25.55	32.99	40.32	51.67	61.83	73.64
4	15.62	20.17	24.65	31.59	37.80	45.02
8	9.55	12.33	15.07	19.31	23.11	27.52
12	7.16	9.24	11.30	14.48	17.33	20.64
24	4.38	5.65	6.91	8.85	10.59	12.62



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Table 12: Intensity with considering the effect of climate

Time (t)	Intensity (mm/hr)					
	T = 2	T = 5	T = 10	T = 25	T = 50	T = 100
0.25	117.13	151.20	184.82	236.85	283.40	337.54
0.5	71.60	92.43	112.99	144.79	173.25	206.35
1	43.77	56.51	69.07	88.51	105.91	126.14
2	26.76	34.54	42.22	54.11	64.75	77.11
4	16.36	21.12	25.81	33.08	39.58	47.14
8	10.00	12.91	15.78	20.22	24.20	28.82
12	7.50	9.68	11.83	15.16	18.14	21.61
24	4.58	5.92	7.23	9.27	11.09	13.21

3.2 Analysis of Peak Discharge

Methodology

The main aim of this study is to calculate the design rainfall intensity which can be used to calculate the peak storm water discharge to design the storm water drains. To design the storm water drainage system, peak runoff needs to be calculated. For this type of studies, the most commonly used procedures are Rational Method, Unit Hydrograph Method, SCS Curve Number Method (SCS-CN), Empirical/Formula-Based Methods, Statistical / Frequency Analysis Hydrologic Modeling (e.g., HEC-HMS, SWMM) etc. Among of this method Rational Method is the most popular one. The Rational Method is widely used to estimate direct runoff and peak discharge.

Steps in the Rational Method.

Procedure for estimation of runoff

The formula for calculating peak flow is given as below:

$$Q_p = 10CIA \quad \dots\dots\dots (4)$$

Q_p = peak discharge (m^3/hr)

C = runoff coefficient, dimensionless

I = Average rainfall intensity should be taken for the duration of rainfall equal to the time of concentration, mm/hr

A = Total Catchment area (hectares)

Where, A (Catchment area) = 98.346 Acre = 0.398 Km^2 = 397992.142 m^2

A_1 = Area of forest = 394362.568 m^2

A_2 = Asphaltic Pavement = 3629.574 m^2



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Runoff coefficient

The coefficient of runoff (C), is a function of the nature of surface and assumed to be the same for all storms of all recurrence probabilities. Recommended values of C on various surface types of the catchments are given in below:

Forest land (C_1) = 0.20

[Source: https://stormwater.pca.state.mn.us/index.php?title=Runoff_coefficients_for_different_soil_groups_and_slopes and <https://www.lmnoeng.com/Hydrology/rational.php>]

Asphaltic Pavement (C_2) = 0.95 [Source: ASCE and WPCF 1969]

Industrial Area (C_3) = 0.90 [Source: ASCE and WPCF 1969]

So, C for the project area before construction = $(C_1 A_1 + C_2 A_2) / (A_1 + A_2) = 0.2068$

Time of concentration (t_c)

The rainfall intensity (I) in the rational formula is the average rainfall intensity over a given duration equal to the time of concentration for the drainage area. The time of concentration (t_c) is defined as flow travel time taken from the hydraulically most remote point in the contributory catchment to the point under consideration. The time of concentration for drain sizing is the time required for water to travel from the most hydraulically distant point in the total contributing catchment to the design point. Typically, this time consists of two components:

- Time for the surface flow to reach the first inlet, i.e., t_0
- Time to flow through the storm drainage system to the point of consideration i.e. t_f .

$$t_c = t_0 + t_f \quad \dots\dots\dots (5)$$

Time of surface flow (t_0)

$$t_0 = \frac{0.218(1.1 - C)L^{0.5}}{S^{0.333}} \quad \dots\dots\dots (6)$$

Time of flow (t_f)

$$t_f = \frac{L_{\text{drain}}}{V} \quad \dots\dots\dots (7)$$

$$V = \frac{1}{n} R^{0.67} S^{0.5} \quad \dots\dots\dots (8)$$

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V = Velocity of flow, m/sec

L = Length of surface flow, m

n = Manning's roughness coefficient

R = Hydraulic radius, m

S = Longitudinal slope

L = 910 m (length of the largest flow path) (Fig. 6a)

S = 0.043

n = 0.050 [Source: CPHEEO, MoUD, "Manual on Sewerage and Sewage Treatment", (2013)]

R = 0.171 m (average for the site)

Time of surface flow (t_0) = 16.75 minutes (by using equation 6)

Time of flow (t_f) = 716.42 sec = 11.94 minutes (by using equation 7)

Time of concentration (t_c) = 28.69 minutes = 0.478 hr (by using equation 5)

Peak discharge calculation**50 years return period:**

I = Average rainfall intensity should be taken for the duration of rainfall equal to the time of concentration, mm/hr = 178.87 mm/hr

C = runoff coefficient = 0.2068

A (Catchment area) = 98.346 Acre = 0.398 Km² = 397992.142 m² = 39.80 hectares

Peak discharge,

$$Q_p = 10CIA$$

$$Q_p = 14722.15 \text{ m}^3/\text{hr} = 4.09 \text{ m}^3/\text{s}$$

100 years return period:

I = Average rainfall intensity should be taken for the duration of rainfall equal to the time of concentration, mm/hr = 213.05 mm/hr

C = runoff coefficient = 0.2068

A (Catchment area) = 98.346 Acre = 0.398 Km² = 397992.142 m² = 39.80 hectares

Peak discharge,

$$Q_p = 10CIA$$

$$Q_p = 17535.38 \text{ m}^3/\text{hr} = 4.87 \text{ m}^3/\text{s}$$

Similar way peak discharge for the other return period can be calculated.

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For a rainfall duration of 1 hr, the corresponding rainfall intensities are 101.14 mm/hr and 120.46 mm/hr for return periods of 50 and 100 years, respectively, as presented in Table 11. Based on these values, the estimated peak discharges are 2.31 m³/s and 2.75 m³/s, respectively.

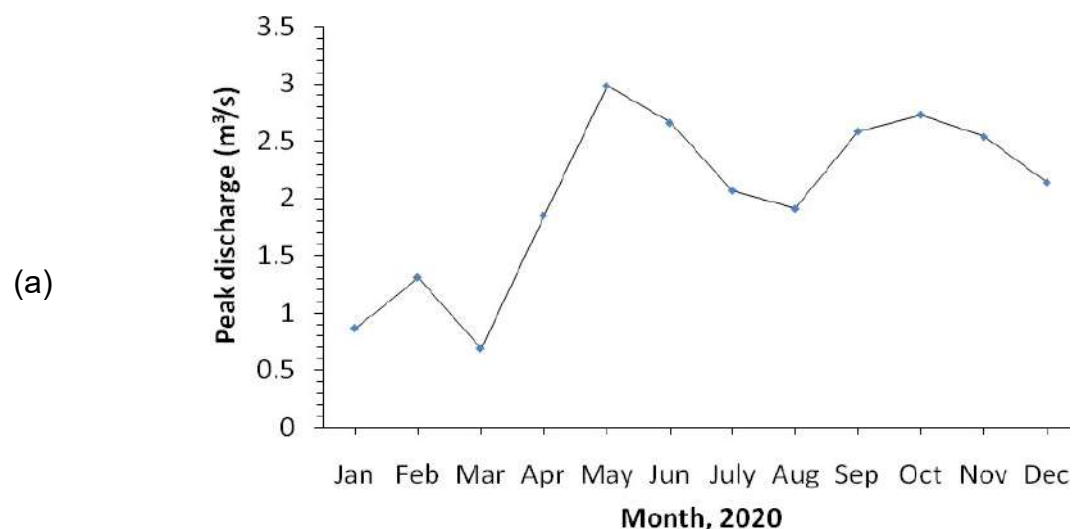
3.3 Flood Hydrograph

Flood hydrograph was calculated based on the maximum daily rainfall at each month of every year from the duration of 2020 to 2024. The maximum daily rainfall at different month of each year is given below:

Table 13: The maximum daily rainfall (mm) at different month of each year

Y\M	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
2024	2	7	1	20	85	60	28	22	55	65	52	31
2023	38	9	89	7	63	37	81	61	43	49	51	15
2022	35	42	128	12	34	63	44	48	56	102	60	66
2021	249	29	24	13	28	40	46	24	85	27	23	53
2020	14	0	17	50	192	43	54	54	89	30	113	45

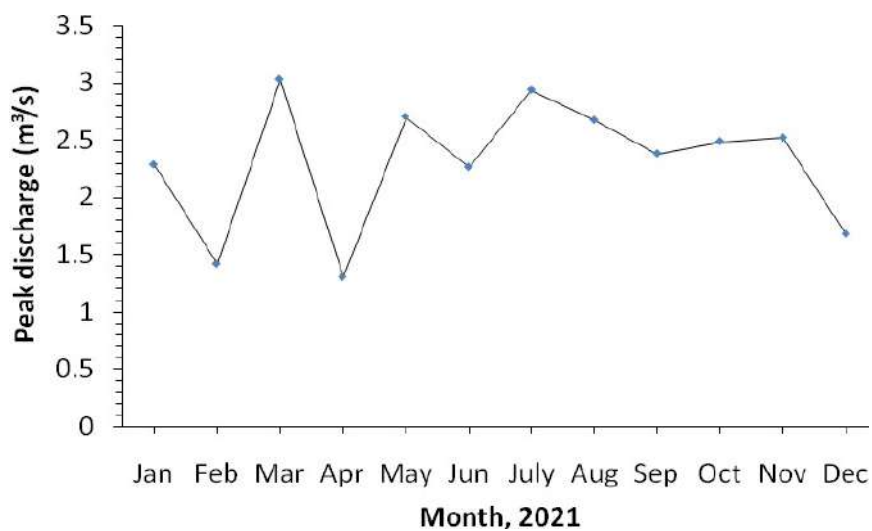
By using the above data and equation the flood hydrograph with respect to the month of every year is shown below (for 100 years return period):



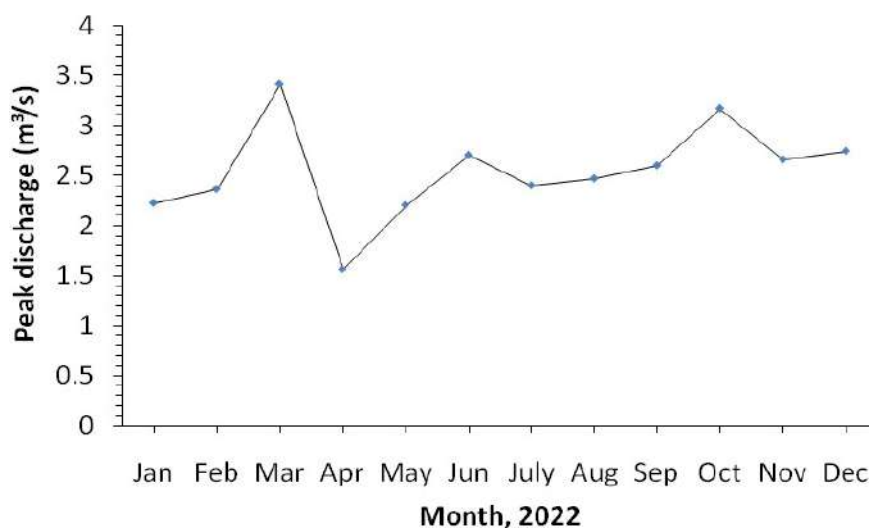
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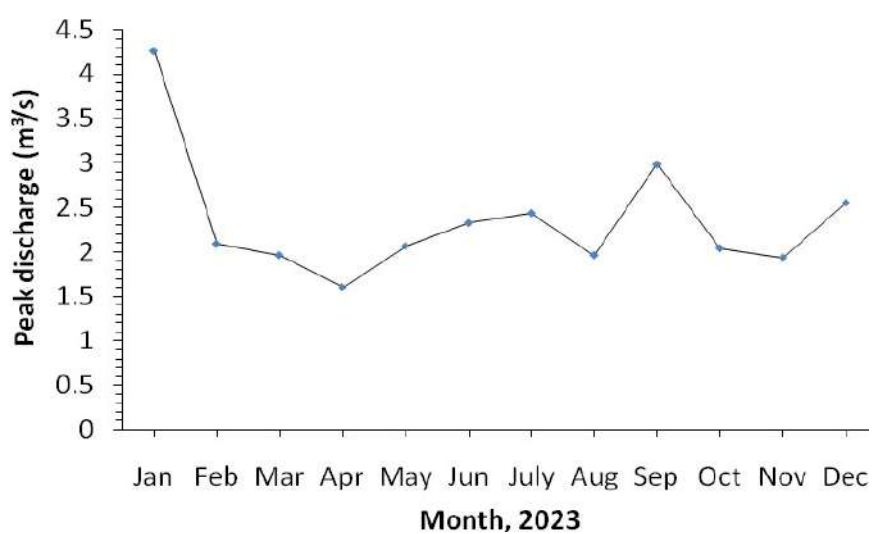
(b)



(c)



(d)





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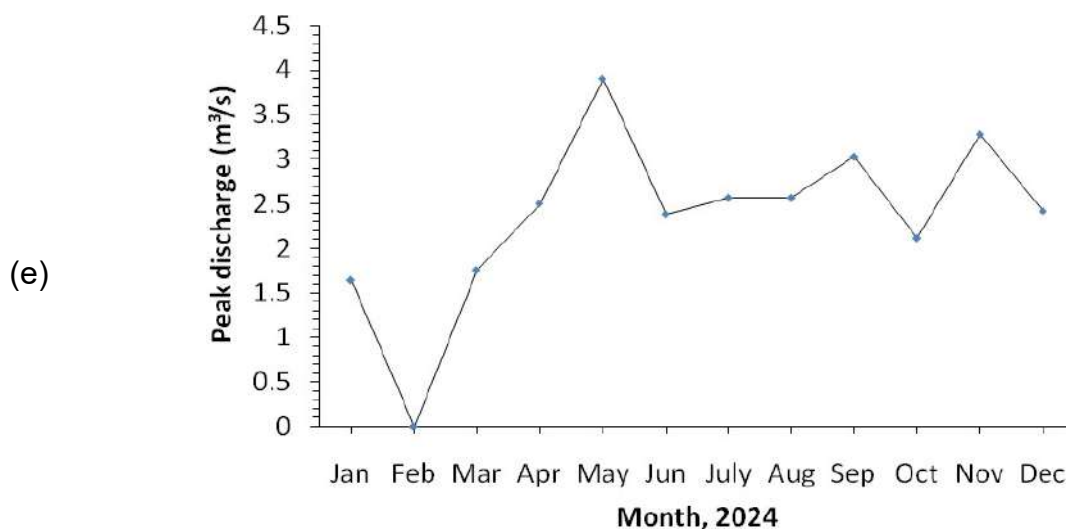


Fig. 9 Flood hydrograph.

Between 2020 and 2024, the peak discharge values observed over the years show some fluctuations. In 2020, the peak discharge was the highest at 2.98 m³/s, indicating a significant event or heavy rainfall during that year. The following year, 2021, saw a marked decrease in peak discharge, with the value dropping to 3.03 m³/s. However, the years after 2021 experienced an increase in peak discharge values. In 2022, the peak discharge decreased to 3.41 m³/s, followed by a slight increase in 2023 to 4.25 m³/s. By 2024, the peak discharge further increased to 3.90 m³/s, continuing the upward trend observed since 2021. These variations in peak discharge over the years could be indicative of changing weather patterns, land use, or other factors influencing water flow during each period.

3.4 Flood Vulnerability Study

A study conducted by the National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO), Department of Space, and the Government of India assessed flood vulnerability zones across India. The study concluded that Great Nicobar is not within the flood vulnerability zone (Fig. 10).



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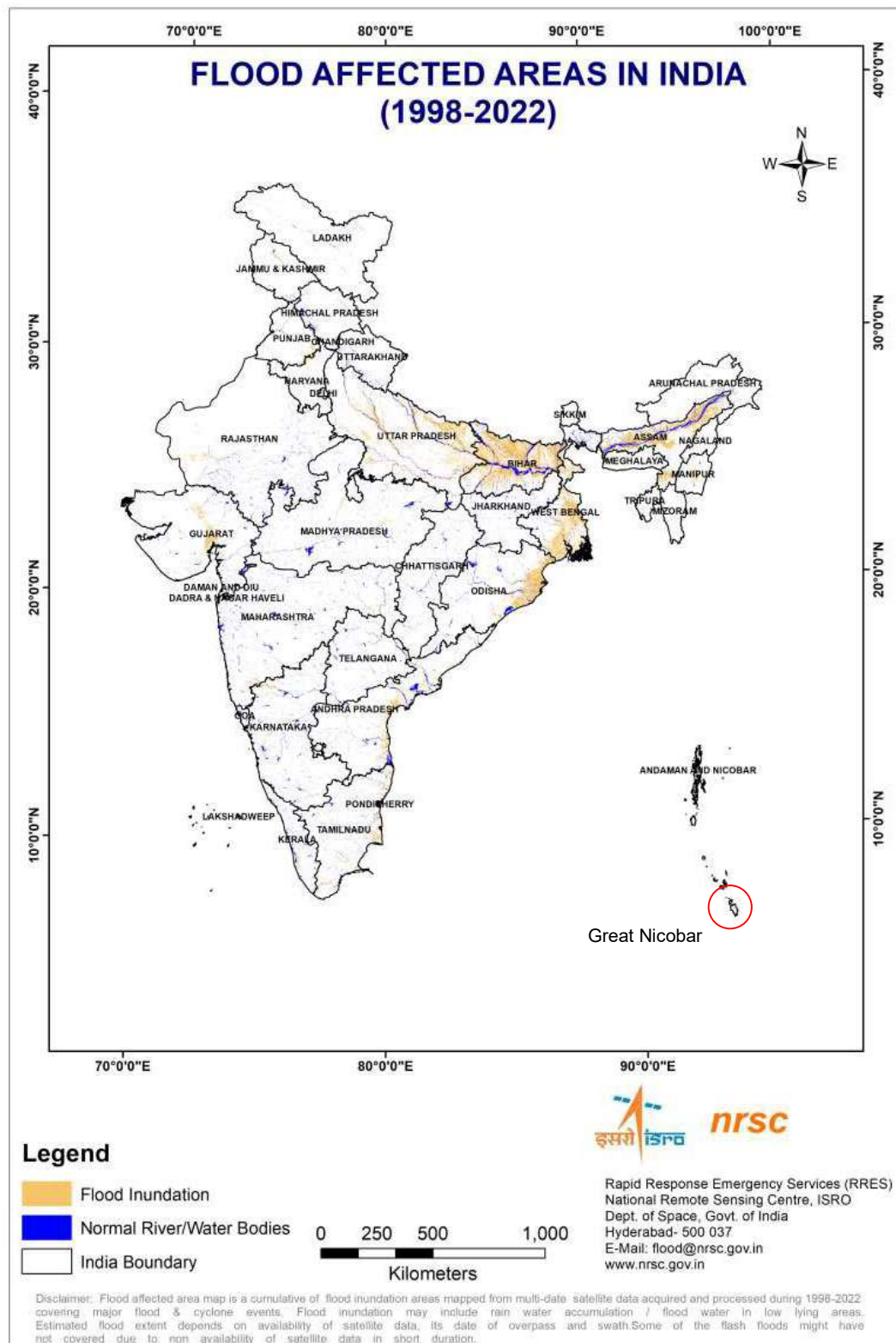


Fig. 10 Flood Affected Area in India Flood Affected Area.

(<https://ndem.nrsc.gov.in/documents/downloads/Flood%20Affected%20Area%20%20Atlas%20of%20India%20-Satellite%20based%20study.pdf>)

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High Flood Level (HFL)

Based on the information provided by the local government departments and local peoples, no major flood was occurred in the region. That's why high tide level was considered as HFL for that region. The high tide data was taken from the various locations, near to the project area. The highest water level was measured by using DGPS during high tide, when the water level was the maximum. Additionally, the data was collected from watermarks created by tides. Tides data was also collected from the available online sources (<https://www.tideschart.com/Indonesia/Aceh/Kota-Sabang/Galathea-Bay/>).

Based on the available information and DGPS survey data, the average high tide level (HTL) is 2.14 to 2.25m.

The lowest RL value at the study location was 4.5 m, which is significantly higher than the Highest Tide Level (HTL) or Highest Flood Level (HFL). Even when the HTL is doubled to account for a safety factor, the elevation of the project location still remains higher than the adjusted HTL. Due to the high peak discharge capacity, the likelihood of flooding is very low. Only flash floods may occur as a result of intense rainfall.



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3.5 Storm Water Drainage

Fig.11 illustrates the drainage pattern corresponding to the proposed construction plans.

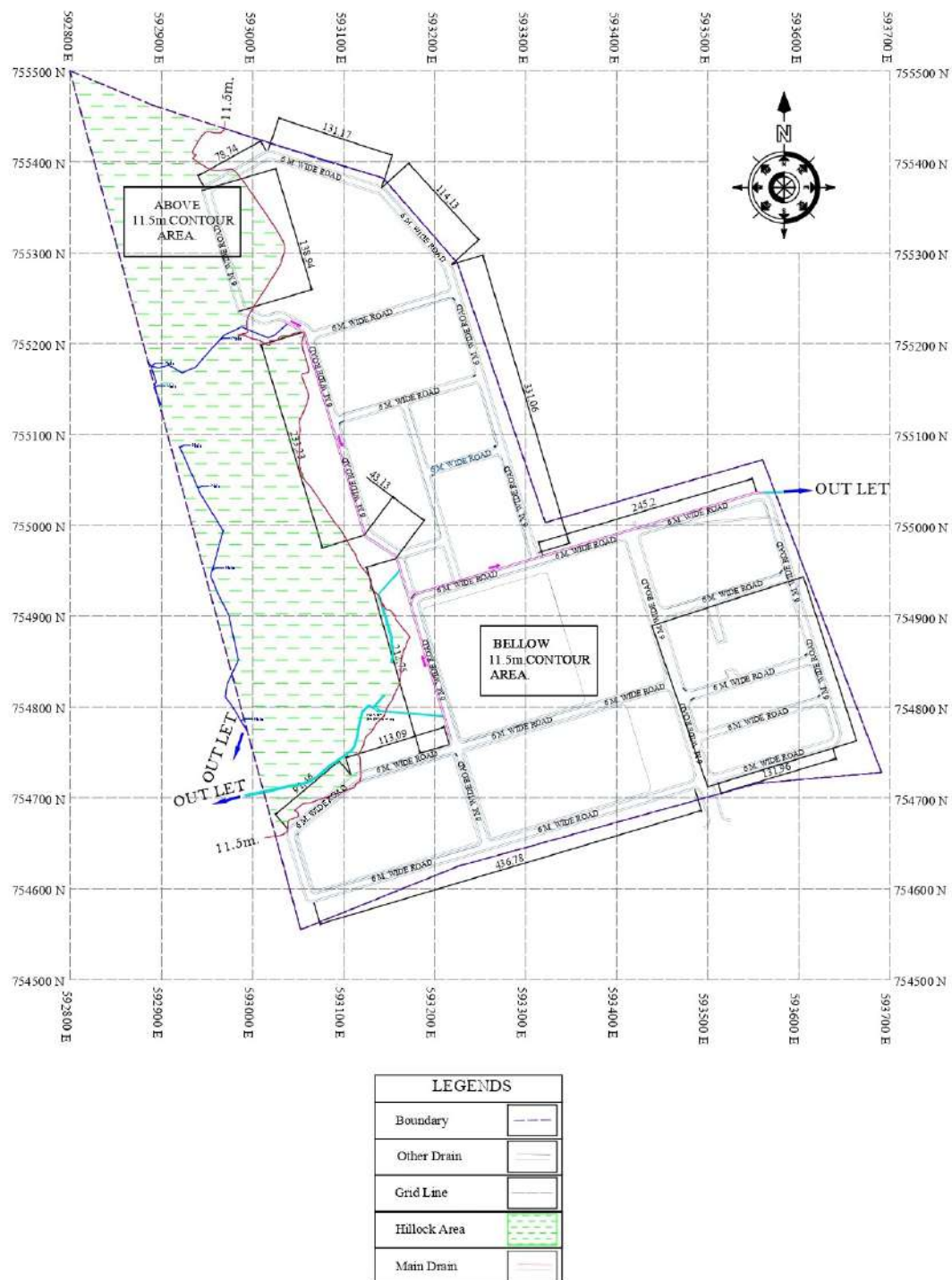


Fig. 11 Storm water drainage

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Time of concentration (T_c)

A_1 = Area of forest = 29.155 acres

A_3 = Industrial Area = 69.145 acres

Forest land (C_1) = 0.20

[Source: https://stormwater.pca.state.mn.us/index.php?title=Runoff_coefficients_for_different_soil_groups_and_slopes and <https://www.lmnoeng.com/Hydrology/rational.php>]

Industrial Area (C_3) = 0.90 [Source: ASCE and WPCF 1969]

C for the project area after construction = $(C_1 A_1 + C_3 A_3) / (A_1 + A_3) = 0.692$

Longest drainage path (L) = 386m (earthen drain) + 1311m (concrete drain) = 1697m
(Fig. 11)

S = 0.024

n = 0.05 (Partially obstructed with debris or weeds)

n = 0.018 (Neat Cement Plaster)

[Source: CPHEEO, MoUD, "Manual on Sewerage and Sewage Treatment", (2013)]

So, average n = 0.0253 (by, weighted average method)

R = 0.171 m (average for the site)

Time of surface flow (t_0) = 12.686 minutes (by using equation 6)

Time of flow (t_f) = 15.08 minutes (by using equation 7)

Time of concentration (t_c) = 27.76793 minutes = 0.463 hr (by using equation 5)

Peak discharge calculation**50 years return period:**

I = Average rainfall intensity should be taken for the duration of rainfall equal to the time of concentration, mm/hr = 182.97 mm/hr

C = runoff coefficient = 0.692

A (Catchment area) = 98.346 acre = $0.398 \text{ Km}^2 = 397992.142 \text{ m}^2 = 39.80 \text{ hectares}$

Peak discharge,

$$Q_p = 10CIA$$

$$Q_p = 50392.87 \text{ m}^3/\text{hr} = 14.00 \text{ m}^3/\text{s}$$

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100 years return period:

I = Average rainfall intensity should be taken for the duration of rainfall equal to the time of concentration, mm/hr = 217.92 mm/hr

C = runoff coefficient = 0.692

A (Catchment area) = 98.346 acre = 0.398 Km² = 397992.142 m² = 39.80 hectares

Peak discharge,

$$Q_p = 10CIA$$

$$Q_p = 60018.65 \text{ m}^3/\text{hr} = 16.67 \text{ m}^3/\text{s}$$

Similar way peak discharge for the other return period can be calculated.

Now, for rainfall duration of 1 hr, the corresponding rainfall intensities are 101.14 mm/hr and 120.46 mm/hr for return periods of 50 and 100 years, respectively, as presented in Table 11. Based on these values, the estimated peak discharges are 7.74 m³/s and 9.22 m³/s, respectively.



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4.0 Tsunami and Cyclone

4.1 Tsunami

Tsunami data was collected from the field as well as available sources like literature, available online documents etc. The tsunami data was collected from two available studies, conducted by Porwal et al., 2012; Sharma and Kar, 2005. As per the available information, the height of tsunami waves varied from 3.5m to 11.5m. Tsunami waves also contaminated the water resources in the low-lying coastal areas of the affected islands (Fig. 12).



Fig. 12 Sea water ingress in Great Nicobar

(Source: <https://www.cgwb.gov.in/oldwebsite/DistrictProfile/AandN/Nicobar.pdf>.)

2004 Indian Ocean Tsunami

Event: On December 26, 2004, a massive undersea earthquake (magnitude 9.1–9.3) off the west coast of Sumatra triggered a devastating tsunami.

Impact on Great Nicobar:

- The tsunami waves struck the island three times, with the second wave being the most destructive.
- Inundation reached several kilometers inland, causing widespread destruction in areas like Jogindar Nagar.
- Approximately 97% of the island's mangrove cover was lost due to the tsunami and subsequent land subsidence.
- 2004 tsunami partly damaged the lighthouse at Indira Point, which subsided 4.25 m. As a result of this subsidence, the coast retreated and the sea moved



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permanently inland. The lighthouse has since been repaired. The base of the lighthouse was 5 m above sea level when constructed in 1972. After the tsunami, the sea floor fell and the base was less than 1 m above sea level. Since then, the subsidence has decreased somewhat as the ocean floor slowly rebounds, and the lighthouse base become more elevated. Indira point was mostly submerged (Fig 13a).

- A temple, at Campbell Bay was partially submerged due to effect of Tsunami, 2004 (Fig 13c).
- A large area of Gandhi Nagar was totally submerged and destroyed by, 2004 Tsunami (Fig 13d).



(a)



(b)



(c)



(d)

Fig. 13 (a) Indira Point. (b) Campbell bay, grater Nicobar. (c) Indira point before and after tsunami. (d) Gandhi Nagar, grater Nicobar.

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According to available data, the tsunami waves generated during the 2004 event had heights ranging from approximately 3.5 m to 11.5 m (Sharma and Kar, 2005). The study conducted by Porwal et al. (2012) indicates that the study area may have been partially affected by the 2004 tsunami (Fig. 14).

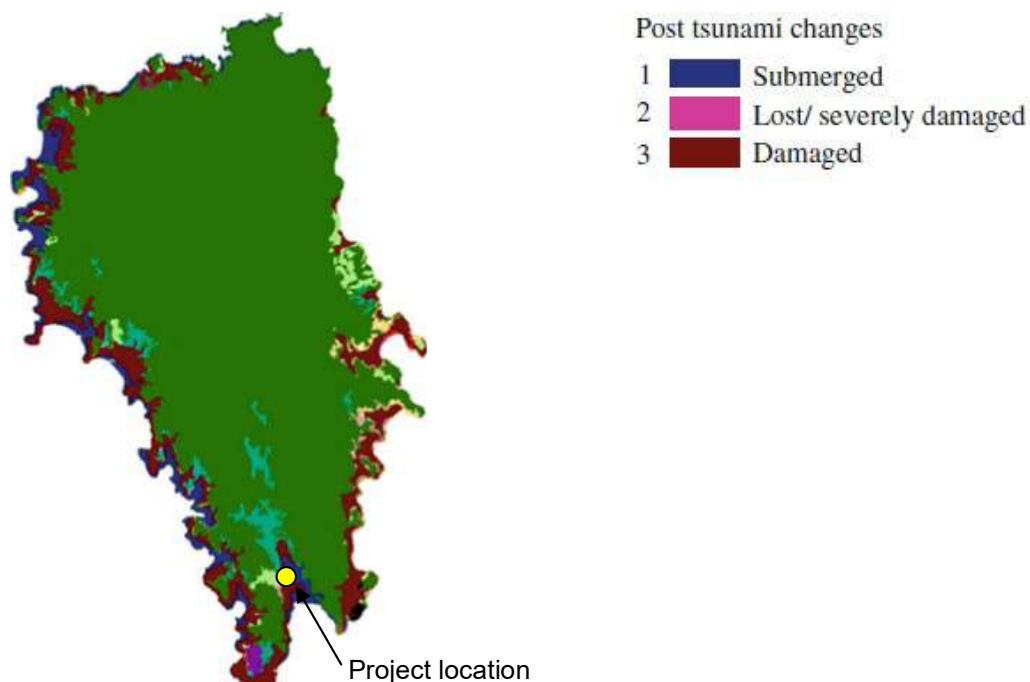


Fig. 14 Impacts of 2004 tsunami in Grater Nicobar (Porwal et al. 2012).

Also, the lowest ground level in the study area is 4.5 m, which means the area could be flooded if tsunami waves are higher than this. Based on these observations and the available elevation data, the likely extent of the submerged area during the tsunami event has been delineated and is illustrated in Fig. 15. In light of these findings, effective mitigation measures must be implemented to ensure the safety of life and property within the project area.



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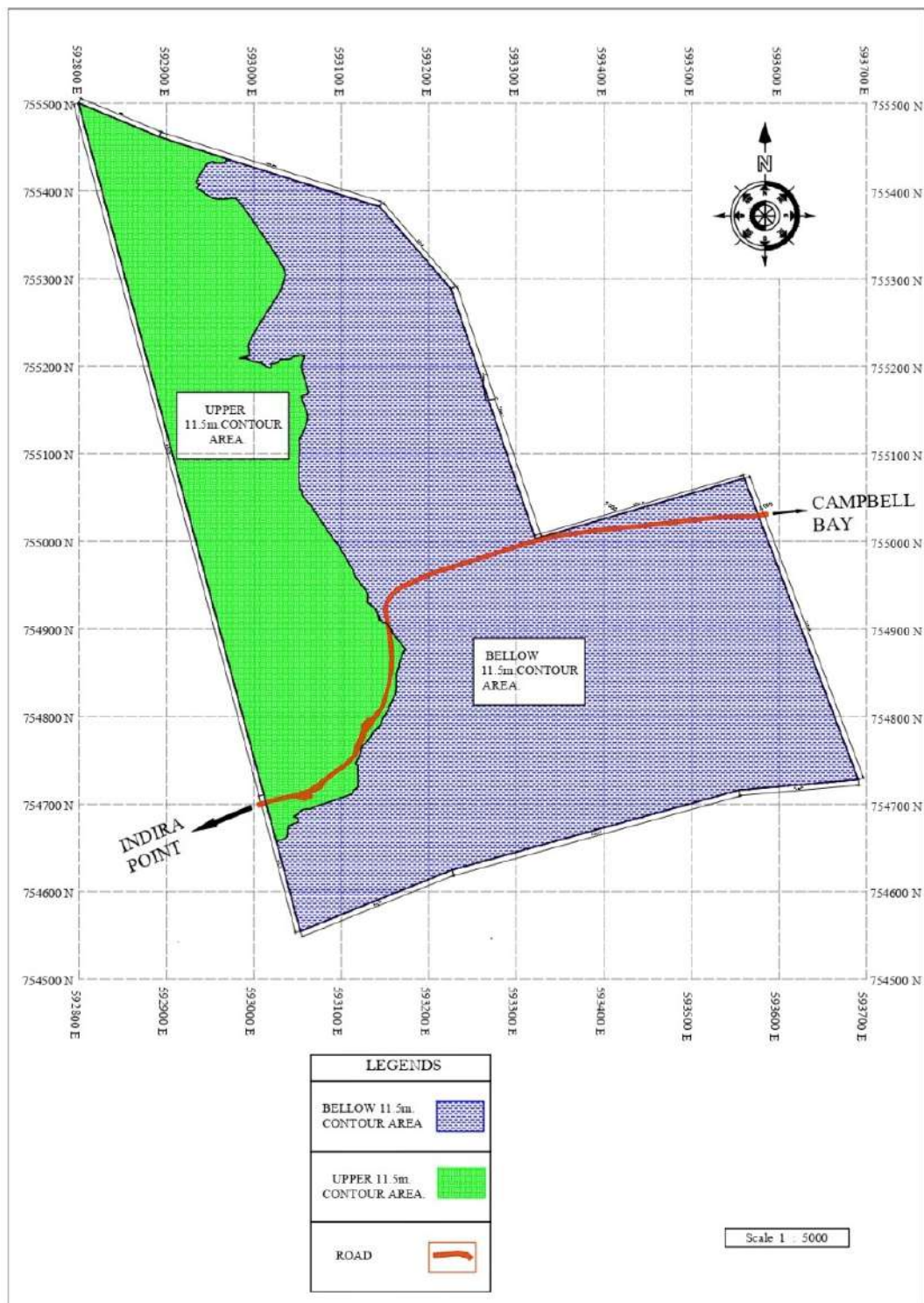


Fig. 15 The probable submerged area based on the available data.

Over the past century, the Nicobar Islands have experienced several tsunamis besides the devastating 2004 event. Notable instances include:

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December 31, 1881 – Car Nicobar Island Tsunami: An undersea earthquake near Car Nicobar Island generated a tsunami with waves reaching approximately 1.2 meters in height. While this event caused minimal damage compared to other tsunamis, it is a significant part of the region's seismic history.

August 27, 1883 – Krakatoa Eruption and Tsunami: The catastrophic eruption of Krakatoa in Indonesia led to massive tsunamis affecting surrounding regions, including the Nicobar Islands. Waves from this event were recorded at heights of about 2 meters in the area.

November 27, 1945 – Makran Coast Tsunami: An earthquake off the Makran Coast in Pakistan, with a magnitude of 8.0, triggered a tsunami that reached the western coast of India. While the Nicobar Islands were not directly in the path of the highest waves, the event underscores the region's vulnerability to distant seismic activities.

4.2 Cyclone

The Bay of Bengal is highly susceptible to cyclogenesis, particularly during the pre-monsoon (April–May) and post-monsoon (October–December) periods. Great Nicobar has historically been impacted by cyclonic events such as Cyclone Akash (2007) and Cyclone Mora (2017), which brought strong winds, heavy rainfall, and flooding. Cyclones contribute to short-duration, high-intensity rainfall which can exceed 200–300 mm/day, overwhelming natural drainage systems.

The project site in Great Nicobar Island located in a cyclone-prone zone of the Bay of Bengal and surrounded by hilly terrain, experiences unique impacts during cyclonic events. The topography plays a dual role offering both protection and challenges. The surrounding hills act as a natural barrier, reducing wind speeds on the leeward side and providing partial shelter from the direct impact of cyclonic winds. However, these same hills intensify rainfall through orographic lifting, where moist air is forced upwards, resulting in heavy localized downpours. During cyclones, intense short-duration rainfall often exceeds 150 to 200 mm/day, leading to rapid surface runoff due to steep slopes. This runoff accumulates quickly in the valley systems, significantly increasing the risk of flash floods, gully erosion, and slope instability. The combination of wind and water-related hazards necessitates robust planning measures for any infrastructure development. These include designing

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drainage systems capable of handling extreme events, accounting for high runoff coefficients in hydrological modeling (such as using the SCS-CN method), reinforcing structures against wind loads per national standards (IS:875 Part 3), and implementing slope stabilization and erosion control strategies. The drainage system is already discussed in Section 8.

4.3 Tsunami and Cyclone Mitigation Measures

As per the available information, the tsunami waves during past events ranging in height from approximately 3.5 m to 11.5 m caused significant destruction in low-lying coastal areas of the affected islands. In addition to widespread structural damage, these waves contaminated freshwater resources, exacerbating the humanitarian crisis in the aftermath. To reduce the vulnerability of coastal communities to such natural hazards, the following mitigation measures are recommended:

Construction of Seawalls, Breakwater and Tsunami Barriers: Reinforced concrete or rubble mound structures, such as seawalls and revetments, can significantly reduce the energy of incoming tsunami waves and limit coastal inundation. Their design should incorporate historical data on wave height, run-up distance, and flow velocity to ensure site-specific effectiveness and structural resilience.

The maximum arial distance from the project site to the Galathea Bay is about 1.5 km. on the other side the distance from the project site to Bay of Bengal is about 3 km. The hillock/high land on the northern side of the project site may act as Tsunami barrier.

However towards the Galathea Bay to such highland/ hill is available, sea wall/Breakwater is required to be constructed at Galathea Bay side.

Cyclone-Resistant and Elevated Housing: Buildings in cyclone prone zones should be designed with wind- and water-resistant materials and elevated above the maximum expected water levels to prevent flood damage.

Coastal Embankments and Natural Buffers: Embankments, dunes, mangroves, and coral reefs should be preserved or restored to act as natural barriers, reducing wave energy and protecting inland areas.



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5.0 Optimize safe grade level

The optimized safe grade elevation was calculated using the weighted average method. The safe grade elevation was determined using the following formula:

$$RL_{safe} = \frac{A_1 RL_1 + A_2 L_2 + A_3 L_2 + \dots}{A_1 + A_2 + A_3 + \dots}$$

A_1, A_2, A_3, \dots = smallest area of each segment (m^2).

L_1, L_2, L_3, \dots = elevation of each smallest segment (m).

RL_{safe} = optimized safe grade elevation (m).

For the project area optimized safe grade elevation approximately,

$$RL_{safe} = 6.384 \text{ m} \approx \mathbf{6.50 \text{ m}}$$

For this elevation cutting and filling will be approximately same,

$$\text{Cutting soil volume} = \text{Filling soil volume} = 186746.9194 \text{ m}^3$$

$$\text{Cutting area approximately} = 186309.943 \text{ m}^2 \text{ (Fig. 16)}$$

$$\text{Filling area approximately} = 93509.943 \text{ m}^2 \text{ (Fig. 16)}$$

*Note: The optimized safe grade elevation was calculated only for the plain region, covering an area of 69.145 acres (Fig. 6a).



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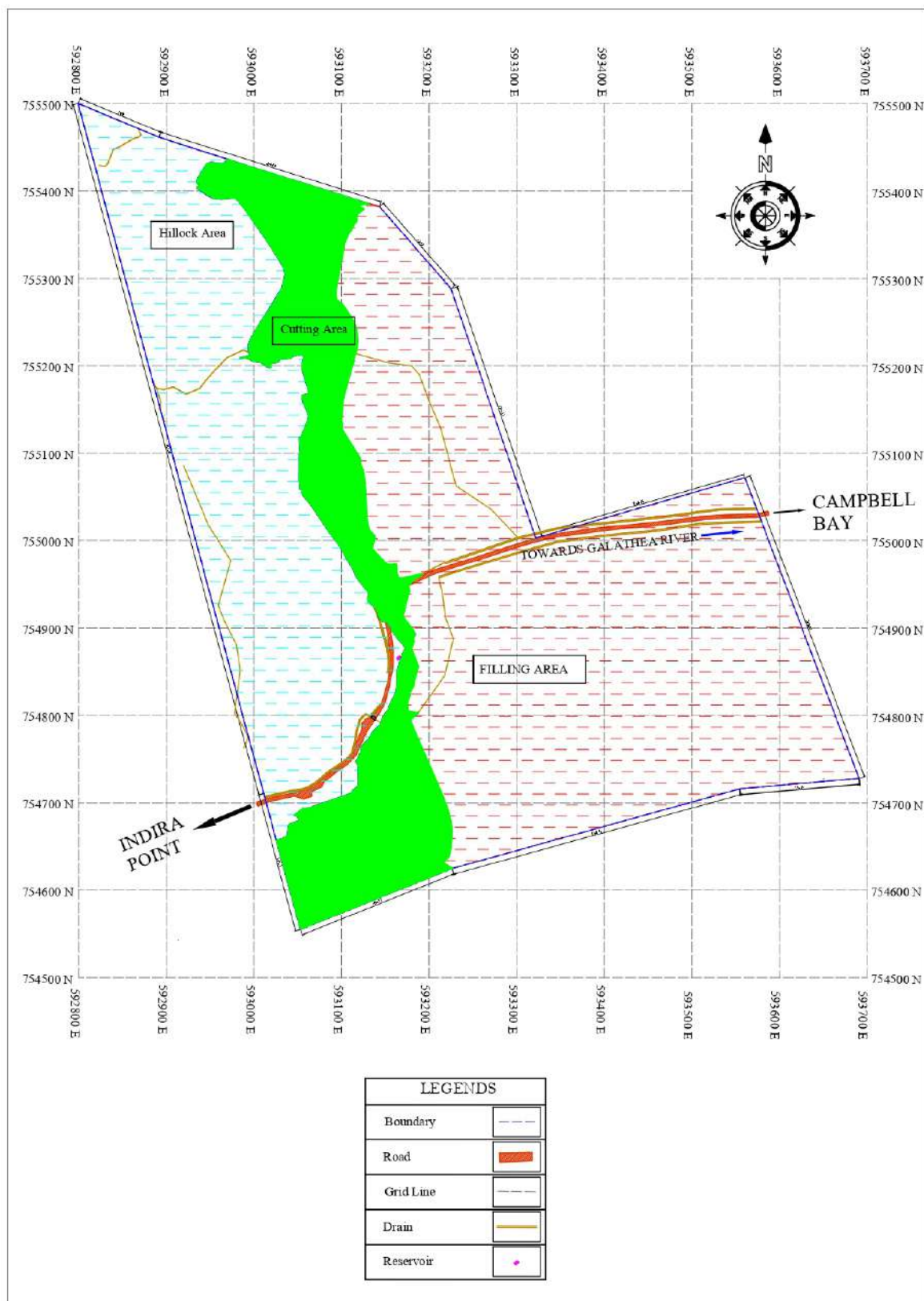


Fig. 16 Cutting and Filling area.

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6.0 Conclusions and Recommendations

6.1 Conclusions

The proposed development of a 108 MW LNG-based power plant at Great Nicobar Island demands a thorough understanding of the region's drainage patterns. Based on the analysis of satellite imagery, published literature, field surveys, and topographic maps, the following key conclusions have been drawn:

- The project site lies in a relatively low-lying area within the generally hilly terrain of Great Nicobar Island. Elevations across the site range from approximately 4.5 m to 65 m above mean sea level (MSL).
- The island's drainage system is characterized by a radial to dendritic pattern, influenced by the central highlands. Major rivers such as the Galathea, Alexandra, and Amrit Kaur facilitate surface runoff into the surrounding coastal regions. Of these, the Galathea River is particularly significant for the southern portion of the island, including the proposed project area.
- The project area encompasses approximately 98.3 acres, which can be broadly categorized into two zones: a hillock region covering about 29.155 acres, and a plain region extending over 69.145 acres.
- Great Nicobar Island experiences substantial rainfall, with an annual average ranging from 3,000 to 3,500 mm. The majority of this precipitation occurs between May and December, driven by both the southwest and northeast monsoons.
- Rainfall intensity data indicate a peak of 178.87 mm/hr for a 50 years return period, increasing to 213.05 mm/hr for a 100 years return period, during pre project scenario, for time of concentration 0.478 hr.
- The peak discharge for the site was calculated at 4.09 m³/s and 4.87 m³/s, for the return period of 50 and 100 years respectively, during pre project scenario.
- Rainfall intensity data indicate a peak of 182.97 mm/hr for a 50 years return period, increasing to 217.92 mm/hr for a 100 years return period, during post project scenario, for time of concentration 0.463 hr.

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- The peak discharge for the site was calculated at 14.00 m³/s and 16.67 m³/s, for the return period of 50 and 100 years respectively, during post project scenario.
- For rainfall duration of 1 hr, the corresponding rainfall intensities are 101.14 mm/hr and 120.46 mm/hr for return periods of 50 and 100 years, respectively, and the respective peak discharges are 7.74 m³/s and 9.22 m³/s.
- Based on the available information and DGPS survey data, the average high tide level (HTL) is 2.14 to 2.25m. The lowest RL value at the study location was 4.5 m, which is significantly higher than the Highest Tide Level (HTL) or Highest Flood Level (HFL). Even when the HTL is doubled to account for a safety factor, the elevation of the project location still remains higher than the adjusted HTL.
- Optimized safe grade elevation of the project area is approximately 6.50 m.
- Cutting soil volume and Filling soil volume is approximately 186746.9194 m³
- Some areas within the project site consist of swampy land.
- The 2004 Indian Ocean tsunami generated wave heights reaching up to 11.5 m, significantly surpassing the site's lowest elevation of 4.5 m MSL. This underscores the area's susceptibility to coastal flooding.

6.2 Recommendations

Safe Grade Level: The final ground level in the project area should be raised above 4.5 m, as this is the lowest existing elevation and poses a flood risk. And for minimum cutting and filling the final ground level in the project area should be 6.384m.

Historical data from the 2004 tsunami event indicates wave heights ranging from approximately 3.5 m to 11.5 m. Based on this, safe grade level of site may be 12.5 m. However, such an elevation is not practically suitable for the current project site due to site constraints.

It is important to note that predicting the height of future tsunami events remains highly uncertain, and the potential impact could exceed historical records. In this context, mitigation would be the most viable approach.

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GT road is planned just adjoining the power plant location and road top levels are yet to be finalized.

A final call for the protection measures may be taken once the road top level is finalized as the road will act as barrier in between the sea and power plant location.

The proposed area is safe with respect to the high tide levels and high floor level of the nearby River.

Drainage Design:

- The drainage system must be designed to accommodate a peak discharge of 4.87 m³/s under pre-project conditions.
- Under post-project conditions, the system should manage a peak discharge of 16.67 m³/s to ensure adequate runoff management and flood prevention.

Final disposal point: According to the layout plan, the designated ultimate discharge point (6.826941° N, 93.846191° E) is situated in the direction of the main gate of the project site. Consequently, an adequate ground slope must be ensured in that direction, accompanied by a well-designed drainage system. This will facilitate the efficient conveyance of excess rain water to the Galathea River (distance within 300m), there by mitigating the risk of flooding and associated hazards.

Coastal Protection Structures: Reinforced concrete or rubble mound structures, such as seawalls and breakwater, should be constructed along vulnerable coastal stretches to reduce tsunami wave energy and protect inland areas from inundation.

Natural Buffer Zones: A green buffer zone should be created through tree plantation, especially with salt- and wind-tolerant species. This will help in reducing the impact of both tsunamis and cyclones, while also supporting ecological sustainability.

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Annexure – (i)

Table 1: Climate at Andaman and Nicobar Island (Source: <http://andssw1.and.nic.in/ecostat/2010/metrologicalstatistics2010.pdf> and <http://andssw1.and.nic.in/ecostat/2008/Meteorological/Temperature.pdf>)

Sl No.	Year	Rainfall (in mm)	Rainy Days	Maximum	Minimum	Humidity (%)	Humidity (%)	Average Wind Speed
				Temperature (°C)	Temperature (°C)			(km/h)
1	2024	2728.05	154	33.6	21.6	80.00	90.00	8.00
2	2023	3290.61	130	31.68	25.25	76.33	80.5	6.79
3	2022	2587.2	129	30.62	25.08	78.33	81.83	4.13
4	2021	3461.0	147	30.72	24.92	78.83	82.42	5.38
5	2020	2881.8	131	30.77	24.92	77.33	81.67	7.21
6	2019	2954.43	116	30.87	24.5	77.25	80.83	6.87
7	2018	2959.8	134	30.5	24.7	79	83	7.46
8	2017	2866.6	132	30.9	24.9	79	83	7.5
9	2016	2833.19	122	31.2	24.8	78	81	8.08
10	2015	2837.13	136	31	24.7	78	81	6.67
11	2014	2597.76	120	31	24.83	77	80	7.83
12	2013	3672.34	158	31	24.5	80	83	9.01
13	2012	3428.5	157	31	24.1	81	84	8.91
14	2011	3771.6	166	30.8	24.4	82	85	10.7
15	2010	3126.6	159	31.3	24.6	80	83	6.74
16	2009	2531.6	151	30.7	24.5	78	81	8.4
17	2008	3254.8	158	30.2	24	80	82	9.8
18	2007	2665.3	145	30.2	23.9	78	82	9.6
19	2006	2538.6	149	30.2	23.9	78	81	8
20	2005	2714.5	153	30.5	24.3	77	80	5.8
21	2004	2436.7	147	30.5	24.2	76	79	7
22	2003	2483.6	130	30.4	24.2	77	80	7.2
23	2002	2287.1	140	30.5	23.5	77	81	7.8
24	2001	2800.7	159	30.2	23.5	78	81	7.5
25	2000	2429	154	29.9	23.3	79	81	7.8
26	1999	2693.8	209	29.8	22.8	79	82	7
27	1998	2751.9	192	30.6	23.2	78	81	6.8
28	1997	2396.7	158	30.3	23.1	76	79	8.4
29	1996	3206.5	178	30	23.6	78	82	7.7
30	1995	3016.5	180	30.2	23.8	78	80	7.8

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31	1994	3044.0	151	30.1	23.4	77	80	9
32	1993	2390.6	142	30	24	75	78	7.4
33	1992	2290.2	139	29.6	23	76	80	9.4
34	1991	2585.4	145	30	23.7	77	79	9.5
35	1990	2265.1	163	29.9	24.2	79	81	8.8
36	1989	2493.4	184	29.6	20.4	78	79	9.4
37	1988	2913.8	199	29.8	21.6	78	80	9.4
38	1987	2277.8	181	30.2	22.9	77	79	9.4
39	1986	2177.1	174	29.9	22.2	76	79	10.2
40	1985	2503.8	189	29.1	23.3	77	80	10.4
41	1984	2492.3	124	29.8	23.6	77	80	9.8
42	1983	2669.6	137	30	23.4	76	78	8.8
43	1982	2069.9	119	29.9	22.5	77	80	10.2
44	1981	2778.9	127	29.9	23.2	76	81	10.8
45	1980	3278.2	127	30.2	23.1	77	79	10.6
46	1979	1950.3	117	30.2	23.4	76	78	10.7
47	1978	2676.9	130	29.8	21.1	78	79	11
48	1977	2458.4	124	29.8	21	78	80	10.9
49	1976	3166.6	138	29.1	20.8	76	78	11.6
50	1975	3529.6	140	29.4	22.2	79	81	10.7
51	1974	2961	138	29.4	22.3	77	80	NA
52	1973	2980.7	138	29.7	23.6	78	80	NA
53	1972	2979.6	138	29.9	21.9	77	81	NA
54	1971	2970.1	132	30.3	22.5	76	80	NA
55	1970	3222.9	157	30.7	23.2	78	82	NA
56	1969	2714.1	118	30.8	23.3	77	81	NA
57	1968	2705.4	121	30.7	23.5	76	81	NA
58	1967	2975.7	149	30.4	23.2	78	82	NA
59	1966	2927.7	120	30.6	23.3	77	82	NA
60	1965	3215.7	145	30.4	22.9	NA	NA	NA
61	1964	3323.8	142	30.5	23	NA	NA	NA
62	1963	3229.2	185	30	24	NA	NA	NA
63	1962	3260.4	194	30.1	23.7	NA	NA	NA
64	1961	4362.4	197	29.7	23.7	NA	NA	NA
65	1960	3079.9	NA	30.4	23.9	NA	NA	NA
66	1959	3585.7	NA	30.5	23.8	NA	NA	NA
67	1958	3151	NA	30.8	23.9	NA	NA	NA
68	1957	2898.1	NA	30.6	23.5	NA	NA	NA
69	1956	3031.3	NA	29.6	23.8	NA	NA	NA
70	1955	3338.6	NA	29.9	23.8	NA	NA	NA



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71	1954	4027.2	NA	30.3	23.7	NA	NA	NA
72	1953	2876.8	NA	30.2	23.8	NA	NA	NA
73	1952	3019.4	NA	30.1	24.1	NA	NA	NA
74	1951	3274.6	NA	30	23.8	NA	NA	NA
75	1950	2421.6	NA	29.8	23.5	NA	NA	NA
76	1949	3489.3	NA	29.8	23.5	NA	NA	NA

Table 2:Monthly rainfall data (2015 – 2024)

Year / Month	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Jan.	129.58	103.65	279.02	170.67	174.85	4.95	54.57	52.85	40	106.4
Feb.	9.78	32.07	9.05	50.2	11.97	4.08	51.98	171	31.28	1.53
Mar	4.8	4.9	33.28	19.8	19.5	0.2	44.11	132.28	12.33	5.02
Apr.	142.72	3.37	101.42	114.47	39.28	38.47	146.53	47.02	24.68	3.03
May	309.25	186.18	276.05	359.18	231.95	225.5	380.58	540.3	133.52	302.92
June	350.57	414.53	320.85	478.77	611.52	470.3	289.42	271.95	447.28	513.13
July	307.25	275.5	364.61	213.52	213.82	325.4	492.62	491.57	440.67	283.02
Aug.	421.88	237.15	386	366.3	766.03	325.98	487.22	363.07	423.6	375.95
Sep.	505.73	583.77	354.85	343.12	546.53	461.78	605.32	373.76	962.75	352.15
Oct.	259.87	288.42	247.8	296.22	143.15	438.32	377.67	325.58	270.78	280.92
Nov.	252.73	176	223.35	229.73	151.63	188.65	257.45	181.07	363.92	227.48
Dec.	142.97	527.65	270.32	317.82	44.2	197.97	90.38	187.73	139.8	276.5
TOTAL	2837.13	2833.19	2866.6	2959.8	2954.43	2681.6	3277.85	3138.18	3290.61	2728.05



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Annexure – (ii)

Design of Rectangular Drain Using Manning's Equation

Assumptions and Parameters:

- Manning's roughness coefficient (n): 0.018
- Bed slope (S): 0.002
- Channel shape: Rectangular
- Freeboard: 0.3 m

Peak discharge, $Q_p = 16.67 \text{ m}^3/\text{s}$

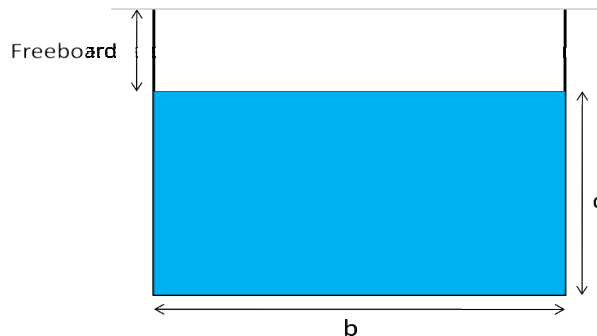


Fig.17 Proposed drain.

By using Manning equation,

$$Q_p = \frac{1}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Trial Design – Case I

Using the trial-and-error method:

- Assumed flow depth (d): 2.5 m
- Assumed bottom width (b): 3.0 m

From this:

- Flow area, $A = d \times b = 2.5 \times 3.0 = 7.5 \text{ m}^2$
- Wetted perimeter, $P = b + 2d = 3.0 + 2 \times 2.5 = 8.0 \text{ m}$
- Hydraulic radius, $R = A / P = 7.5 / 8.0 = 0.9375 \text{ m}$

Therefore, the total depth of the proposed drain, including freeboard, is:

$$\text{Total depth} = 2.5 + 0.3 = 2.8 \text{ m}$$

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Bottom width=3.0 m

Alternative arrangement:

Instead of a single drain, two parallel rectangular drains may be provided, each with approximate dimensions:

- Depth = 2.1 m
- Width = 2.5 m

Revised Design – Case II

Assuming a steeper bed slope of 0.003, and keeping the same assumptions otherwise:

- Assumed flow depth (d): 2.15 m
- Bottom width (b): 3.0 m

Then:

- Flow area, $A = 2.15 \times 3.0 = 6.45 \text{ m}^2$
- Wetted perimeter, $P = 3.0 + 2 \times 2.15 = 7.3 \text{ m}$
- Hydraulic radius, $R = 6.45 / 7.3 \approx 0.884 \text{ m}$

Thus, the total drain depth including freeboard is:

Total depth=2.15+0.3=2.45 m

Bottom width=3.0 m



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Photographs



Road side pucca drain



Road side kacha drain



Swampy land



Galathea river and Andaman sea meeting point



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DGPS surveying under "Area drainage study"



DGPS surveying under "Area drainage study"



Natural drain at the hill area



Natural drain at the hill area

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D-1-9

ANNEXURE-I

GEO-LOGICAL MAPPING REPORT

Geological Mapping Report

Report on
**GEOLOGICAL MAPPING FOR 108MW LNG BASED ENGINE
POWER PLANT AT GREAT NICOBAR ISLAND (GNI), INDIA**



Client:



NTPC Limited
(A Government of India Enterprise)

Consultant:

FICHTNER CONSULTING ENGINEERS INDIA PVT. LTD.

Site Study Sub Vendor:



**Jabakusum House, 34, C. R. Avenue
Kolkata - 700 012,
PH. 033- 4065 8074**

**Email - info@geosolutionindia.com
Website - www.geosolutionindia.com**

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PROJECT	108 MW Gas Based Power Plant DPR
CLIENT	Fichtner Consulting Engineers (India) Pvt. Ltd.
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Report on**GEOLOGICAL MAPPING FOR 108MW LNG BASED ENGINE POWER PLANT AT
GREAT NICOBAR ISLAND (GNI), INDIA****CONTENTS**

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1.3 Purpose and Scope of This Study	
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1.0 Introduction

1.1 General

NTPC Limited (A Government of India Enterprise) is contemplating to set-up power infrastructure in multiple phases with LNG based Gas Engine, PV Solar and Transmission System at Great Nicobar Island as per the mandate from MoP under the plan for Holistic Development of Great Nicobar Island. M/s Fichtner Consulting Engineers (India) Pvt. Ltd. has been appointed as owner's consultant for preparation of Detailed Project Report (DPR) for the said project. M/s Fichtner has selected M/s Geosolution Proservices Pvt. Ltd. (GPPL) for conducting field studies pertaining to DPR preparation. This report has been prepared for partial fulfillment of field studies for DPR preparation.

1.2 Location

Great Nicobar Island is the southernmost and largest island of the Nicobar Islands group, which is part of the Andaman and Nicobar Islands, a union territory of India. It lies in the Bay of Bengal, approximately 150 km north of Sumatra, Indonesia. The island's coordinates are roughly 6.8° N latitude and 93.8° E longitude. Notably, Indira Point, located on Great Nicobar, is the southernmost point of India (Fig. 1).

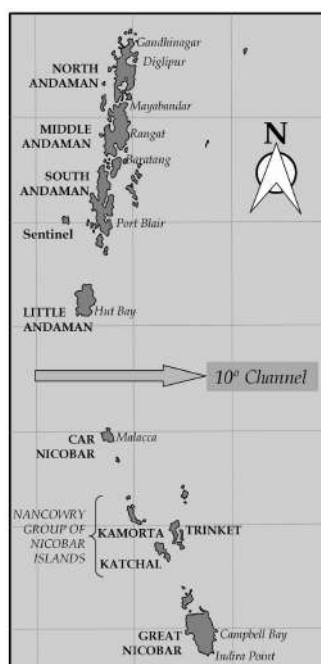


Fig. 1 The A&N islands region, including some of the larger islands.



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The project site is located in the southern part of the Great Nicobar Island, the coordinate is 6.828392° N, 93.844112° E. The project site is located in and around Galathea Bay. The site can be accessed by a metalled road from Campbell Bay and a causeway over the Galathea river. Campbell Bay is connected to Port Blair through Ship and Helicopter Services.

1.3 Purpose and Scope of This Study

NTPC is planning to set up 108MW LNG based engine power plant at Great Nicobar Island (GNI). As part of the Detailed Project Report (DPR) preparation, a comprehensive geological mapping is required for the proposed project site, which spans approximately 100 acres. This study involves the microscopic examination of rock samples to evaluate their mineralogical composition, texture, and microstructural characteristics. In the context of engineering and geotechnical applications, geological mapping plays a critical role in assessing the durability, weathering susceptibility, and mechanical behaviour of foundation rock.

1.4 Topography

Great Nicobar Island covers an area of approximately 921 square kilometers. The island is characterized by undulating hills that predominantly follow a north–south orientation. According to the Land Use and Land Cover map of India, Great Nicobar Island falls under the category of 'Evergreen/Semi-evergreen Woodland' (Fig. 2).

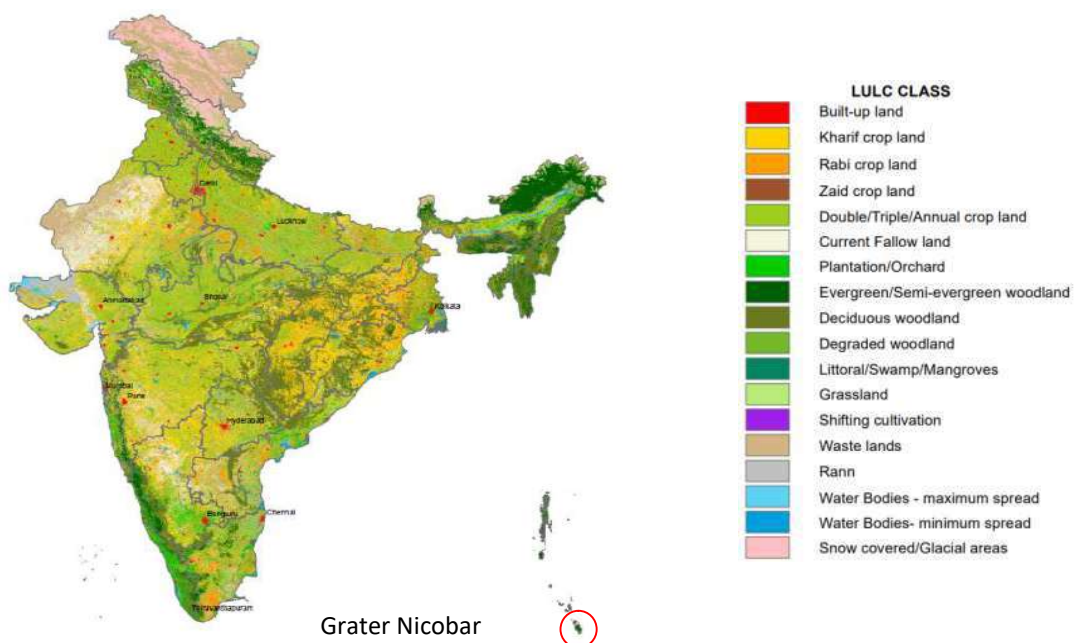


Fig.2 Satellite derived Land use / Landcover Map (2021-22) at 1: 250,000 scale (Source : www.bhuvan.nrsc.gov.in)



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1.5 Climate & Ecology

The island experiences a warm, tropical climate with significant rainfall due to annual monsoons. Its diverse ecosystems include tropical evergreen forests, coastal mangroves, and inland grasslands. The island hosts two national parks Campbell Bay and Galathea and was designated a UNESCO Biosphere Reserve in 2013.

2.0 Methodology

Geological mapping has conducted by Geologists using GPS, clinometer and Brunton compass. GPS, clinometer and Brunton compass are small handheld instruments and don't need any forest clearance. Geological team entered the bushes without causing harm to the small plants/shrubs. Rock samples were collected by small Geological Hammer. Geological Mapping is non-invasive methods and do not need any groundbreaking.

Thin sections were prepared out of collected rock samples and petrographic studies has been conducted with the help of optical microscopes.



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3.1 Lithological Classification of rock

Andaman Flysch: The Andaman Flysch refers to a geological formation found in the Andaman Islands, primarily composed of deep marine sedimentary rocks like shales, sandstones, siltstones, and sometimes conglomerates, typically associated with flysch sequences that are deposited in a tectonically active deep marine basin.

Key Points about the Andaman Flysch:

- **Tectonic Setting:** It represents sediments deposited in a forearc or accretionary prism setting, formed due to the subduction of the Indian Plate beneath the Burma Microplate.
- **Age:** The Andaman Flysch is generally considered to be Late Eocene to Oligocene in age.
- **Lithology:** Predominantly greywacke type sandstones and shales, with features like turbidite structures, suggesting deposition by gravity-driven sediment flows.

Mangrove Swampy Soil: Mangrove swamp soils are characterized by a high organic matter content, fine-grained sediments, low oxygen levels, and high salinity. These soils are typically formed by the accumulation of organic matter and inorganic sediments carried by rivers and tidal currents. They are often waterlogged and may contain a layer of acid sulfate.

3.2 Geomorphology

The area is characterized by a geomorphological landscape of small to moderately high hills near a narrow coast, with the Galathea river flowing nearby.

3.3 Weathering and soil cover

Weathering: Great Nicobar Island experiences strong weathering due to its tropical climate with high rainfall, humidity, and temperature. The main type of weathering here is chemical weathering, which breaks down rocks and minerals over time. Rainwater, rich in carbon dioxide, reacts with minerals in the rocks, leading to their decay. Physical weathering also occurs, especially along the coast due to wave action and temperature changes. The dense vegetation further contributes by producing organic acids that speed up rock breakdown.

The degree of weathering of the rock samples ranges between 25% and 75%, indicating that the samples are moderately to highly weathered.

Soil cover: The soil cover of Great Nicobar Island mainly consists of high organic matter content, fine-grained sediments, low oxygen levels, and high salinity. These

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soils have developed under high rainfall, tropical conditions, accumulation of organic matter and inorganic sediments carried by rivers and tidal currents. They are generally well-drained, and rich in iron and Aluminium oxides. Forested areas have a top layer of humus rich soil. The soil supports dense tropical vegetation, including evergreen forests. (Sharma and Kar, 2005)

3.4 Ground water condition

Within the project area, the groundwater table lies close to the ground surface (within 0.5 m below the ground surface), indicating the presence of an unconfined aquifer.

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4.0 Petrographic Study

Ten rock samples were collected for petrographic analysis. All samples were obtained from the project area, specifically from three different exposures. Based on visual identification, three distinct types of rocks were identified: shale, sandstone, and siltstone. To achieve a more accurate classification and better understanding of the rock types, a microscopic study was conducted. A detailed discussion of the petrographic analysis is presented below.

Location of the rock samples (Fig.3):

Location	Coordinate	Rock samples
1	6°49'37.8"N, 93°50'31.44"E	Sample 1, 2, 3 & 4
2	6°49'39.64"N, 93°50'33.69"E	Sample 5, 6 & 7
3	6°49'43.35"N, 93°50'34.72"E	Sample 8, 9 & 10

A. Petrography Report: Shale of Andaman Flysch

Sample no – 1, 2, 5 & 8

Rock type – Shale

Group – Andaman flysch

General Description

The shale component of the Andaman Flysch forms a significant portion of the sedimentary sequence, characterized by fine-grained, planer laminated argillaceous rocks. These shales are typically dark grey to black in color, but sometimes show various hues which is secondary result from weathering. In hand specimen, they exhibit a smooth surface, low hardness and tend to break along parallel planes, a characteristic feature of fissility in fine-grained sedimentary rocks.

The shales are interbedded with sandstones and siltstone, reflect deposition in a deep marine turbidite system, where fine suspended clays settled from low-energy suspension currents following higher-energy sandstone deposition events.

Microscopic Petrography

Under the microscope, the shale samples from the Andaman Flysch exhibit a compact and fine-grained matrix dominated by clay minerals (illite, chlorite, muscovite sometimes biotite). The clay minerals occur in both flocculated and



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oriented fabrics, indicating episodes of both rapid sedimentation and subsequent compaction.

Quartz grains are present as fine, sub-angular silt-sized detrital particles scattered throughout the matrix. Feldspar grains are relatively rare and often altered to sericite. Biotite and muscovite flakes are aligned parallel to the foliation, suggesting post-depositional compaction.

Organic matter appears as amorphous, dark brown to black patches and lenses within the matrix, with no preferred orientation, showing brighter relatively under reflected light microscopy, indicating an anoxic depositional environment.

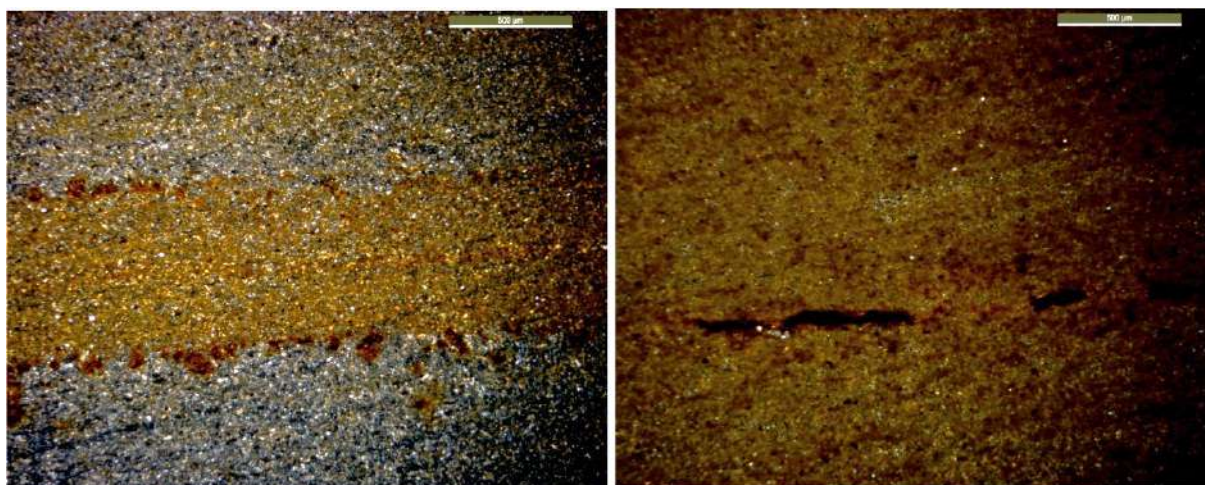


Fig. 4 (a) Ferruginous clay rich layer within shale. (b) scattered organic matter occurring as isolated brown opaque laths throughout the sample.

Mineral	Description (PPL)	Description (XPL)
Clay minerals	Dull grey to brown, often opaque	Low birefringence, dull
Quartz	Colorless, angular	1st-order grey, undulose extinction
Mica	Muscovite- colorless	Varigated interferebce color
	Biotite- green , pleochroic	Masked by body color
Organic matter	Opaque specks	Remain dark in XPL

Texture

- **Grain size:** Mostly <0.062 mm (clay and silt – sized)
- **Fabric:** Well – laminated; parallel alignment of platy minerals (phyllosilicates)
- **Support:** Matrix-supported (clastic grains dispersed in clayey matrix)
- **Compaction features:** Flattened clasts, aligned mica flakes, stylolites of iron oxide occasionally present

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The shale shows a compacted and fissile texture, with a preferred orientation of clay minerals and mica flakes. Primary porosity is minimal due to authigenic clay growth.

Interpretation

The petrography of the Andaman Flysch shale indicates deposition in a deep marine setting within a forearc or trench-slope basin. Fine grain size, high clay content, presence of organic matter, collectively point toward low-energy, anoxic bottom waters typical of distal turbidite environments. The mineralogical maturity is low, and the detrital input is sourced primarily from a recycled orogenic terrain.

B. Petrography Report: Sandstones of Andaman Flysch

Sample no – 7, 9 &10

Rock type – Sandstone

Group – Andaman flysch

General Description

The sandstone appears grey to dark grey in color, fine- to medium-grained, and moderately hard. It exhibits a compact texture with a gritty feel. Bedding is generally massive to faintly graded, with occasional parallel lamination. The rock shows poor to moderate sorting and contains visible angular to sub-angular quartz grains. Some feldspar grains and lithic fragments may be seen with a hand lens. The matrix is abundant, giving the rock a somewhat dirty or muddy appearance typical of greywackes. No significant fossils are visible. The overall fabric suggests deposition by turbidity currents in a deep marine setting.

Microscopic Petrography**Framework Minerals**

Overall grain size suggests it to be a sandstone which is moderately sorted and having angular grains suggesting towards its short transportation. These sandstones are primarily composed of quartz, which serves as the dominant framework mineral. Quartz grains are mostly monocrystalline with undulose extinction, though polycrystalline varieties are also present, comprising small, stretched subgrains with sutured contacts. Some quartz grains display overgrowths. Feldspar is the next significant component, consisting of both K-feldspar—often showing crosshatched twinning—and plagioclase, typically exhibiting thin lamellar twinning. These feldspars occur in both fresh and altered forms, the latter appearing turbid and cloudy. Lithic



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fragments are abundant and predominantly metamorphic clastic, derived from low- to medium-grade metamorphic rocks such as quartz-mica schist, argillites, and metaquartzite, with occasional high-grade varieties. Volcanic fragments, though minor, include altered basalt and felsic volcanic grains and some sedimentary rock fragments have also been observed.

Zircons occur as both rounded grains, suggestive of recycling, and as prismatic grains, indicative of volcanic origin. Muscovite and Biotites are abundant. Muscovite appears as white flakes, whereas biotites are pleochroic; in some instances, the flakes are aligned parallel to the bedding planes. Minor quantities of chlorite and sericite are also observed. Notably grains with perthitic texture in feldspar grain and geaphic textures of quartz in K-feldspar crystals has also been observed.

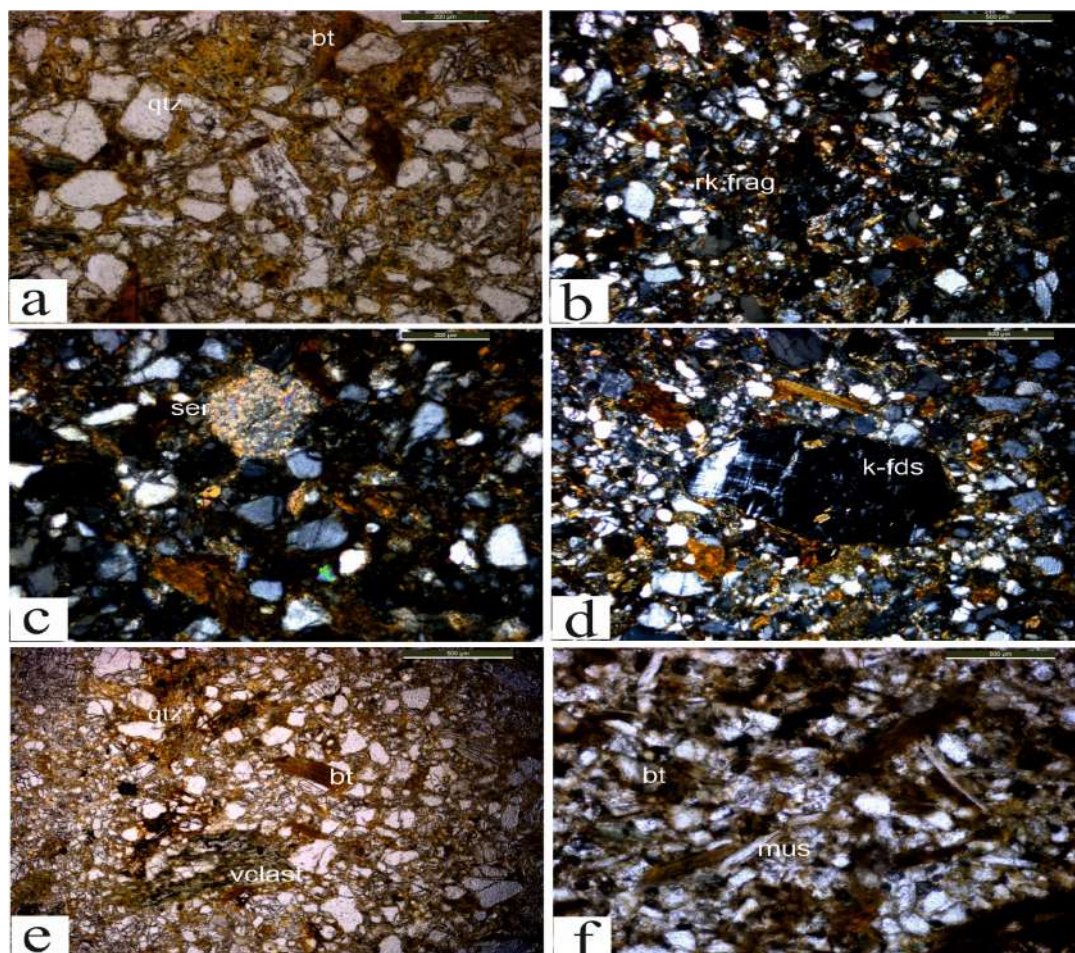


Fig. 5 (a) Angular to subangular grains with clay matrix in-between the clasts. (b) poorly sorted sandstone with abundant clay matrix. (c) feldspar grain completely replaced by sericite (d) Partially altered subhedral microcline with crosshatched twinning (e) Volcanic clast altered to chlorite, having wispy tails. (f) Randomly oriented biotite and muscovite grain throughout the sample. (Qtz- Quartz, ser- sericite,



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Texture

- **Clastic texture:** sub-angular to sub – rounded grains
- **Grain size:** Fine – to medium-grained (0.1 – 0.25 mm)
- **Sorting:** Moderate to poor
- **Fabric:** Typically, subparallel grain alignment; possible graded bedding visible in thin section

The sandstones are poorly to moderately sorted, with grain sizes ranging from coarse silt to medium sand, though fine sands are most common. Grains are angular to sub-angular, with low sphericity, suggesting limited transport and rapid burial. Grain contacts range from point and long tangential to concavo–convex, indicating moderate compaction.

Framework minerals, particularly feldspars and micas, show signs of chemical alteration.

- Feldspars and muscovites are replaced by illitic and chloritic clays
- Biotites transform into chlorite.
- Volcanic fragments show epidote and chlorite alteration.

Matrix content varies from 15 to 50 %, with most samples exceeding 20%. Matrix minerals include illite (dominant), chlorite (pale-green fibrous aggregates), and muscovite.

Two types of matrix are identified: protomatrix (early infiltrated clay films) and epimatrix (product of in-situ grain alteration). As the compaction was low so no pseudomatrix is spotted. Framework interstices are often filled with ferruginous material, along with fibrous clay.

Interpretation

The petrographic and diagenetic features indicate that the Andaman Flysch sandstones are texturally and mineralogically immature, likely derived from low- to medium-grade metamorphic terrains, felsic volcanic arcs, and recycled sedimentary sources. The presence of fresh feldspars, volcanic fragments, and heavy minerals like zircon and tourmaline support multiple source terrains including continental arcs and orogenic belts.



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C. Petrography Report: Siltstone of Andaman Flysch

Sample no – 3, 4 & 6

Rock type – siltstone

Group – Andaman flysch

General Description

The siltstone units within the Andaman Flysch represent an intermediate component between the finer-grained shales and coarser sandstones. In hand specimen, these siltstones are fine-grained, moderately hard, typically thin- to medium-bedded, grey to dark grey in color and often laminated. They appear compact, show moderate fissility, and exhibit parallel lamination, especially near transitions into sandy layers.

Microscopic Petrography

Thin section studies reveal a fine-grained framework dominated by silt-sized quartz, feldspar, and lithic fragments within a clay-rich matrix. Quartz grains are subangular to subrounded, monocrystalline, and typically show undulose extinction. Minor polycrystalline quartz grains, are also present. Feldspar grains—primarily plagioclase—occur as subhedral to anhedral crystals, sometimes showing signs of alteration (clouding, sericitization). Lithic fragments are present in moderate amounts and include fine-grained metamorphic (quartz-mica schists, phyllites) and volcanic rock fragments.

Micas, including muscovite and biotite, are identifiable in oriented flakes aligned parallel to bedding. Chlorite is occasionally seen as a replacement product in altered volcanic grains or biotite. Organic matter is dispersed through the matrix occurring as brown to opaque laths. Micas are oriented in two different sets when viewed under cross nicols.

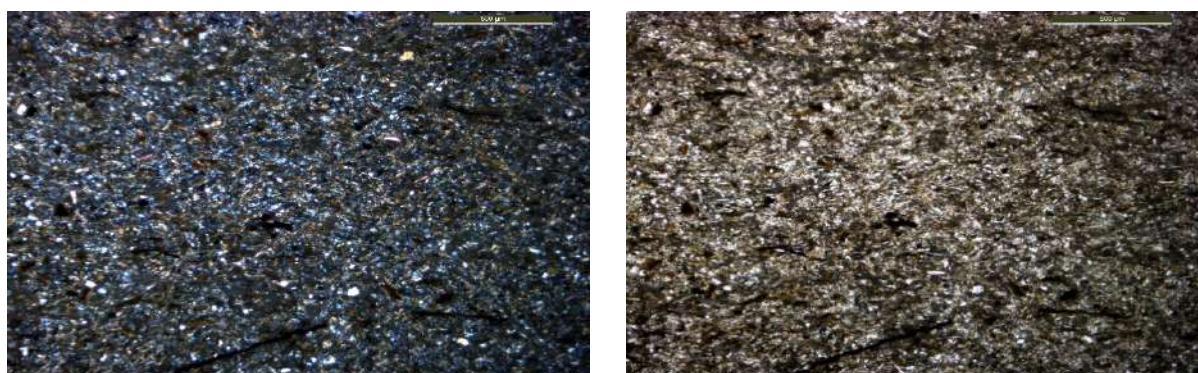


Fig. 3. (a) Brown organic laths dispersed throughout the sample. Micas at the interstitial space between the grain showing two distinct orientation (xpl) (b) fig. 3. (a) in ppl

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

PROJECT	108 MW Gas Based Power Plant DPR
CLIENT	Fichtner Consulting Engineers (India) Pvt. Ltd.
DOCUMENT NO.	GPPL/ FCEIPL/GM/2025-26/R-05
DATE	June, 2025

Texture

Siltstones exhibit moderate sorting and grain support textures with compacted grain frameworks and interstitial clay minerals. The grains are typically tightly packed with tangential or sutured grain boundaries, reflecting burial compaction. Bedding-parallel alignment of phyllosilicates indicates post-depositional mechanical compaction.

Diagenetic features include: Clay mineral transformations, Occasional development of micro-stylolites.

Matrix content typically ranges between 20–40%, with significant portions derived from diagenetic transformations of labile grains and original detrital clays. Pore-filling cement is sparse, mostly ferruginous and siliceous in character.

Interpretation

The siltstones of the Andaman Flysch record deposition under relatively quiet marine conditions following turbidite pulses. Their fine grain size and moderately sorted character suggest suspension settling under waning energy conditions.

Petrographic evidence supports a recycled orogenic provenance, consistent with the flysch's tectonic context. The presence of metamorphic lithics, altered feldspars, and phyllosilicates indicates derivation from continental orogenic belts and subsequent transport through submarine gravity flows. Preservation of the phyllosilicate fabric and more homogeneous structure of the rock suggest minimal bioturbation and deposition in an undisturbed setting.



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5.0 Recommendation on foundation

Types of foundation generally depend on the structural load, geotechnical and geological conditions. The project area is situated under Zone V (IS 1893 – Part 1:2002). These regions are most susceptible to major earthquakes (magnitude > 7.0). So, proper infrastructure design and mitigation techniques are required to protect or minimize the effect of earthquake and associated tsunami effect. Based on the geological map a primary idea about types of foundation is recommended below:

Andaman Flysch: The Andaman Flysch, characterized by alternating layers of sandstone, siltstone, and shale with steep dips, generally supports shallow foundations where sandstone is exposed. However, in areas where shale and siltstone layers are weak or weathered, it is better to use pile foundations that reach down to strong sandstone for better support.

Mangrove Swampy Soil: The mangrove swampy soil consists of soft, compressible, and organic rich deposits with poor load bearing capacity. For such areas, deep foundations such as driven or bored piles are essential to transfer loads to deeper, stable strata. Soil improvement techniques may also be considered to mitigate settlement and enhance performance.

This type of soil is generally susceptible to liquefaction; foundation should be designed keeping liquefaction of soil in mind.





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DATE	June, 2025

Photographs



Rock exposure inside the project area



Rock exposure inside the project area



Collection of rock sample



Collected rock sample



Collected rock samples



Rock exposure outside the project area



Mangrove Swampy Soil portion inside the project area



Mangrove Swampy Soil portion inside the project area



Rock exposure outside the project area

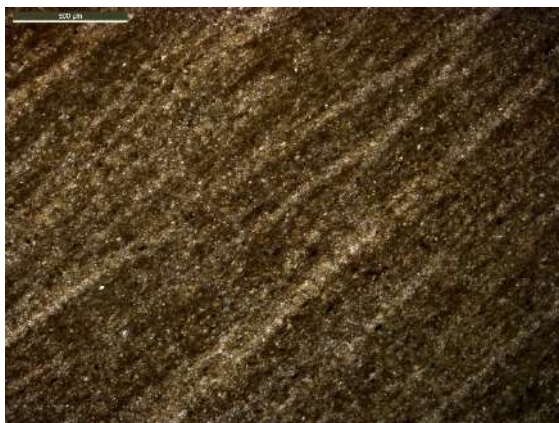


GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

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Microphotographs of the all samples.

SAMPLE 1

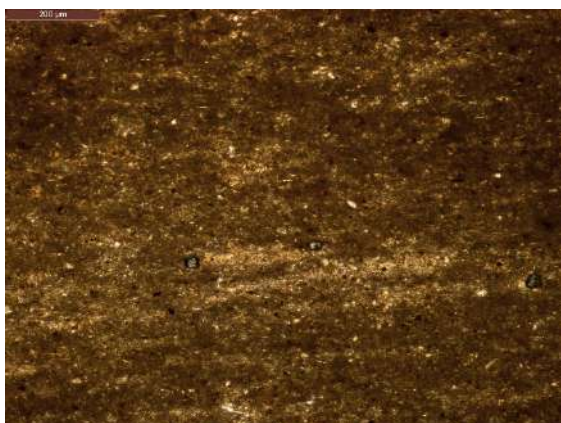


PPL



XPL

SAMPLE 2



PPL

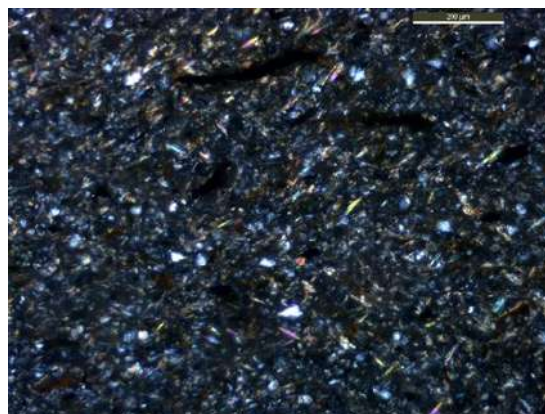


XPL

SAMPLE 3



PPL



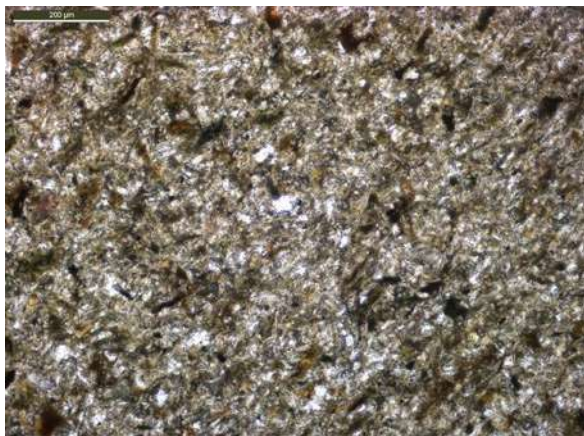
XPL



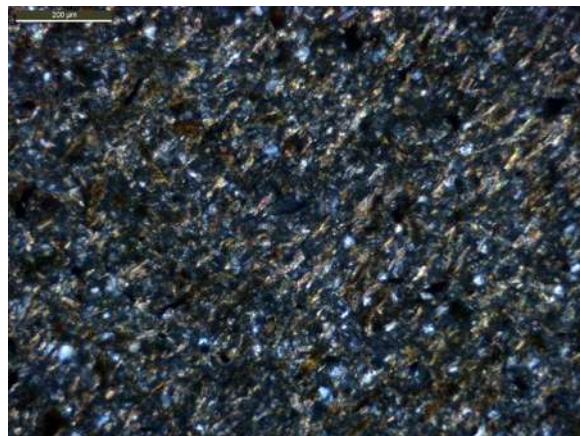
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DATE	June, 2025

SAMPLE 4



PPL



XPL

SAMPLE 5



PPL

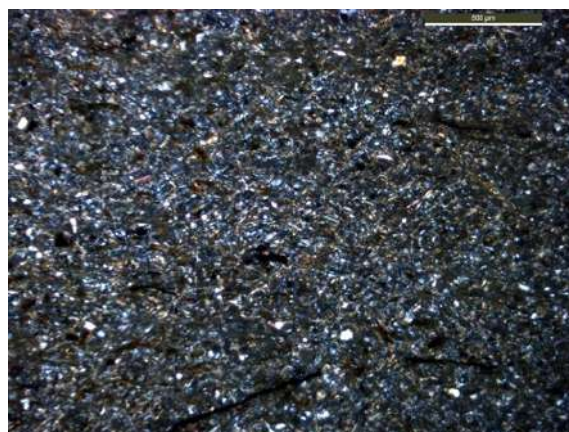


XPL

SAMPLE 6



PPL



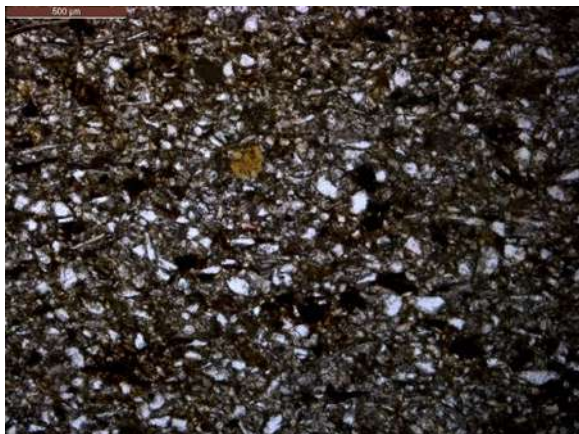
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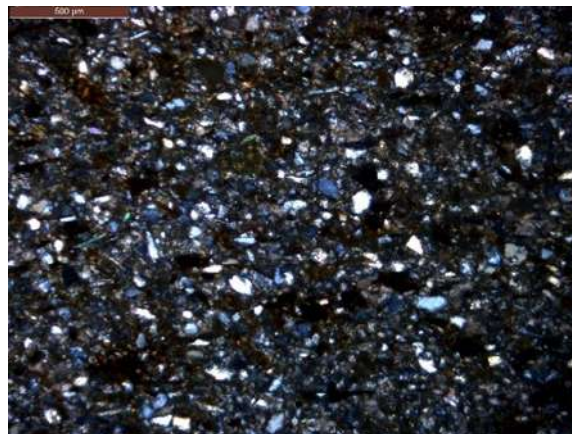
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

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DATE	June, 2025

SAMPLE 7

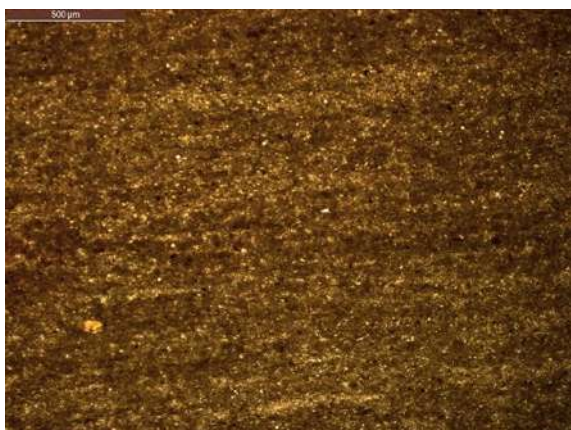


PPL



XPL

SAMPLE 8

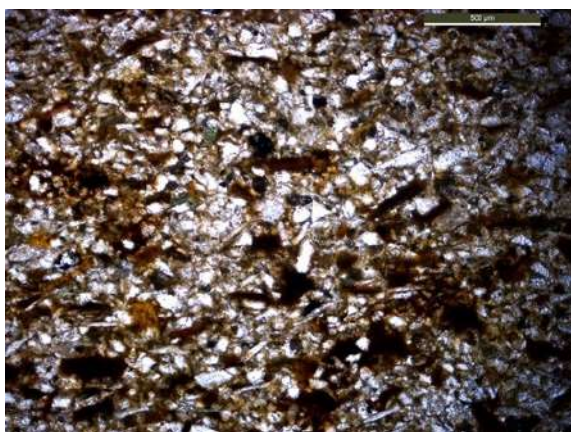


PPL

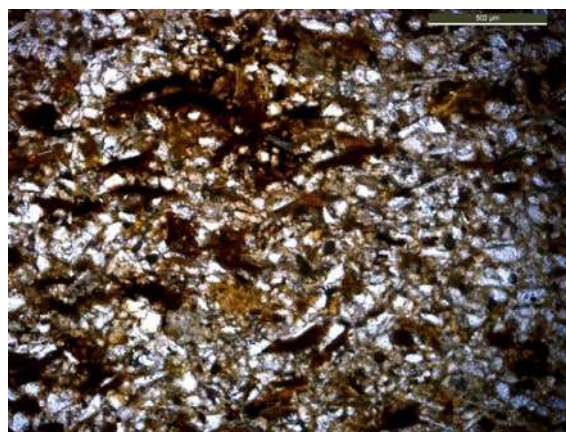


XPL

SAMPLE 9



PPL



XPL



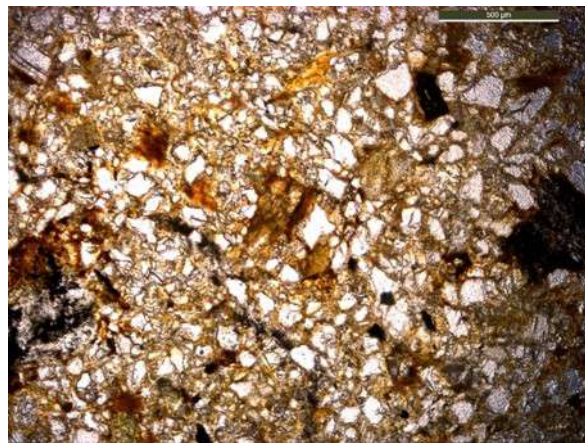
GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA

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DATE	June, 2025

SAMPLE 10



PPL



XPL

PPL = Plane Polarized Light

XPL = Cross Polarized Light

**GEOSOLUTION PROSERVICES PVT. LTD., KOLKATA**

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CLIENT	Fichtner Consulting Engineers (India) Pvt. Ltd.
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DATE	June, 2025

References

Geological Survey of India _ Geological Map of Great Nicobar Island

Geological Survey of India _GSI_, 2003. Seismotectonic Atlas of India and its Environs, Calcutta, India.

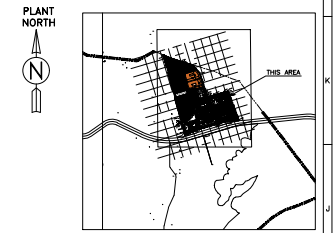
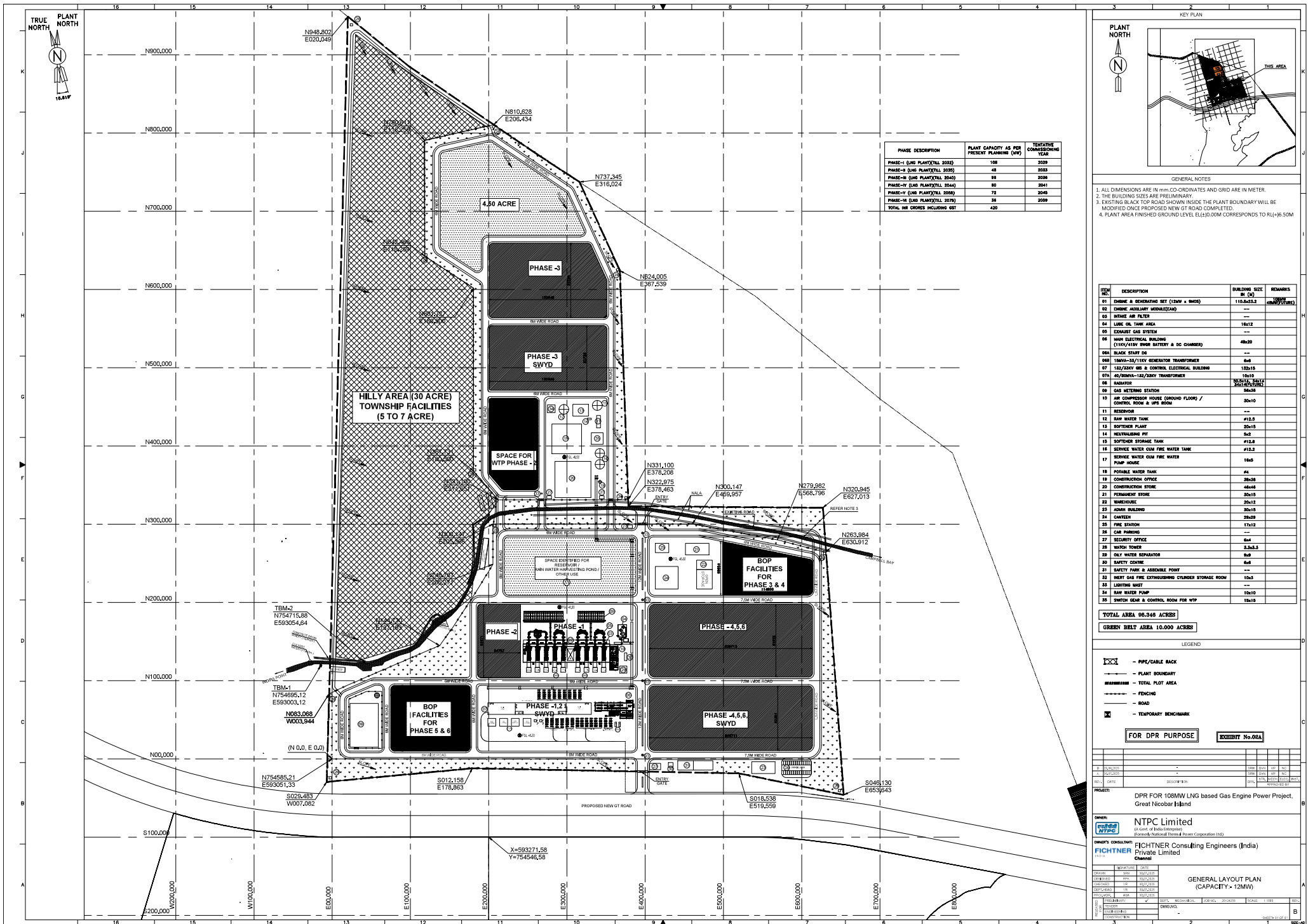
IS 1893 (Part 1):2002. Indian Standard, Criteria for Earthquake Resistant Design of Structures. Part 1 General Provisions and Buildings.

Sharma. J.S., Kar. A. (2005). Government of India Ministry of Water Resources Groundwater Information Booklet Nicobar District, A&N Islands. Scientific Report Series "E". Serial No. 50. [https://www.cgwb.gov.in/oldwebsite/DistrictProfile /AandN/ Nicobar.pdf](https://www.cgwb.gov.in/oldwebsite/DistrictProfile/AandN/Nicobar.pdf)

D-1-10

LIST OF DRAWINGS

CLAUSE NO.	TECHNICAL SPECIFICATION			<div>एन टी पी सी NTPC</div>																																				
D-1-10	LIST OF ALL DRAWINGS																																							
1.00.00	APPLICABLE DRAWINGS FOR THE PACKAGE																																							
The drawings listed below and forming part of the specification shall be supplement to the requirements specified herein. The scope and terminal points of the equipment to be furnished under this package shall be as identified in these drawings and read in conjunction with the text of the specification.																																								
<table><tr><th>Sl.No.</th><th>Drawing Title</th><th>Drawing No.</th></tr><tr><td>1.</td><td>General Layout Plan - 1</td><td>6401-001-POC-A-001</td></tr><tr><td>2.</td><td>General Layout Plan - 2</td><td>6401-001-POC-A-002</td></tr><tr><td>3.</td><td>Topographical Drawings</td><td>6401-001-POC-A-003</td></tr><tr><td>4.</td><td>Bachelor & Suite Accommodation – Ground Floor Plan</td><td>6401-001-POC-A-004</td></tr><tr><td>5.</td><td>Bachelor & Suite Accommodation – First Floor Plan</td><td>6401-001-POC-A-005</td></tr><tr><td>6.</td><td>Bachelor & Suite Accommodation – Elevation & Sections</td><td>6401-001-POC-A-006</td></tr><tr><td>7.</td><td>Geological Map</td><td>6401-001-POC-A-007</td></tr><tr><td>8.</td><td>Typical Admin Building Plan -1</td><td>6401-001-POC-A-008</td></tr><tr><td>9.</td><td>Typical Admin Building Plan -2</td><td>6401-001-POC-A-008</td></tr><tr><td>10.</td><td>Bachelor & Suite Accommodation – Ground Floor Electrical Layout Plan</td><td>6401-500-TOE-A-101</td></tr><tr><td>11.</td><td>Bachelor & Suite Accommodation – First Floor Electrical Layout Plan</td><td>6401-500-TOE-A-102</td></tr></table>					Sl.No.	Drawing Title	Drawing No.	1.	General Layout Plan - 1	6401-001-POC-A-001	2.	General Layout Plan - 2	6401-001-POC-A-002	3.	Topographical Drawings	6401-001-POC-A-003	4.	Bachelor & Suite Accommodation – Ground Floor Plan	6401-001-POC-A-004	5.	Bachelor & Suite Accommodation – First Floor Plan	6401-001-POC-A-005	6.	Bachelor & Suite Accommodation – Elevation & Sections	6401-001-POC-A-006	7.	Geological Map	6401-001-POC-A-007	8.	Typical Admin Building Plan -1	6401-001-POC-A-008	9.	Typical Admin Building Plan -2	6401-001-POC-A-008	10.	Bachelor & Suite Accommodation – Ground Floor Electrical Layout Plan	6401-500-TOE-A-101	11.	Bachelor & Suite Accommodation – First Floor Electrical Layout Plan	6401-500-TOE-A-102
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- GENERAL NOTES
1. ALL DIMENSIONS ARE IN mm CO-ORDINATES AND GRID ARE IN METER.
 2. THE BUILDING SIZES ARE PRELIMINARY.
 3. EXISTING BLACK TOP ROAD SHOWN INSIDE THE PLANT BOUNDARY WILL BE MODIFIED ONCE PROPOSED NEW GT ROAD COMPLETED.
 4. PLANT AREA FINISHED GROUND LEVEL EL+0.00M CORRESPONDS TO RL+6.50M

ITEM NO.	DESCRIPTION	BUILDING SIZE (M ²)	REMARKS
01	ENGINE & GENERATING SET (12MW x 1000)	110x40x2	
02	ENGINE AUXILIARY BUILDING	---	
03	INTAKE AIR FILTER	---	
04	LINE OIL TANK AREA	10x12	
05	EXHAUST GAS SYSTEM	---	
06	MAIN ELECTRICAL BUILDING (110V/415V BROWN BATTERY & DC CHARGER)	40x20	
07	BLACK START DS	---	
08	10MVA-33/11KV GENERATOR TRANSFORMER	6x6	
09	132/20KV GS & CONTROL ELECTRICAL BUILDING	12x15	
10	40/20MVA-132/20KV TRANSFORMER	10x10	
11	INVERTER	10x10	
12	GAS METERING STATION	10x10	
13	AIR COMPRESSOR HOUSE (GROUND FLOOR) / CONTROL ROOM & UPS ROOM	20x10	
14	RESERVOIR	---	
15	RAW WATER TANK	#12.5	
16	SOFTENER PLANT	20x15	
17	NEUTRALISING PIT	5x5	
18	SOFTENER STORAGE TANK	#12.5	
19	SERVICE WATER CUM FIRE WATER TANK	#12.5	
20	PUMP HOUSE	10x5	
21	PORTABLE WATER TANK	#4	
22	CONSTRUCTION OFFICE	20x10	
23	CONSTRUCTION STORE	40x40	
24	PERMANENT STORE	20x15	
25	WAREHOUSE	20x15	
26	ADMIN BUILDING	20x15	
27	CATERING	20x15	
28	FIRE STATION	10x10	
29	CAR PARKING	---	
30	SECURITY OFFICE	6x6	
31	WATER TOWER	2.5x2.5	
32	OUT WATER SEPARATOR	6x6	
33	SAFETY CENTRE	6x6	
34	SAFETY PANEL & ASSEMBLY POINT	---	
35	HEAVY GAS FIRE EXTINGUISHING CYLINDER STORAGE ROOM	15x5	
36	LIGHTING MAST	10x10	
37	RAW WATER PUMP	10x10	
38	SWITCH GEAR & CONTROL ROOM FOR WTP	10x10	

TOTAL AREA 96.546 ACRES
GREEN BELT AREA 10.000 ACRES

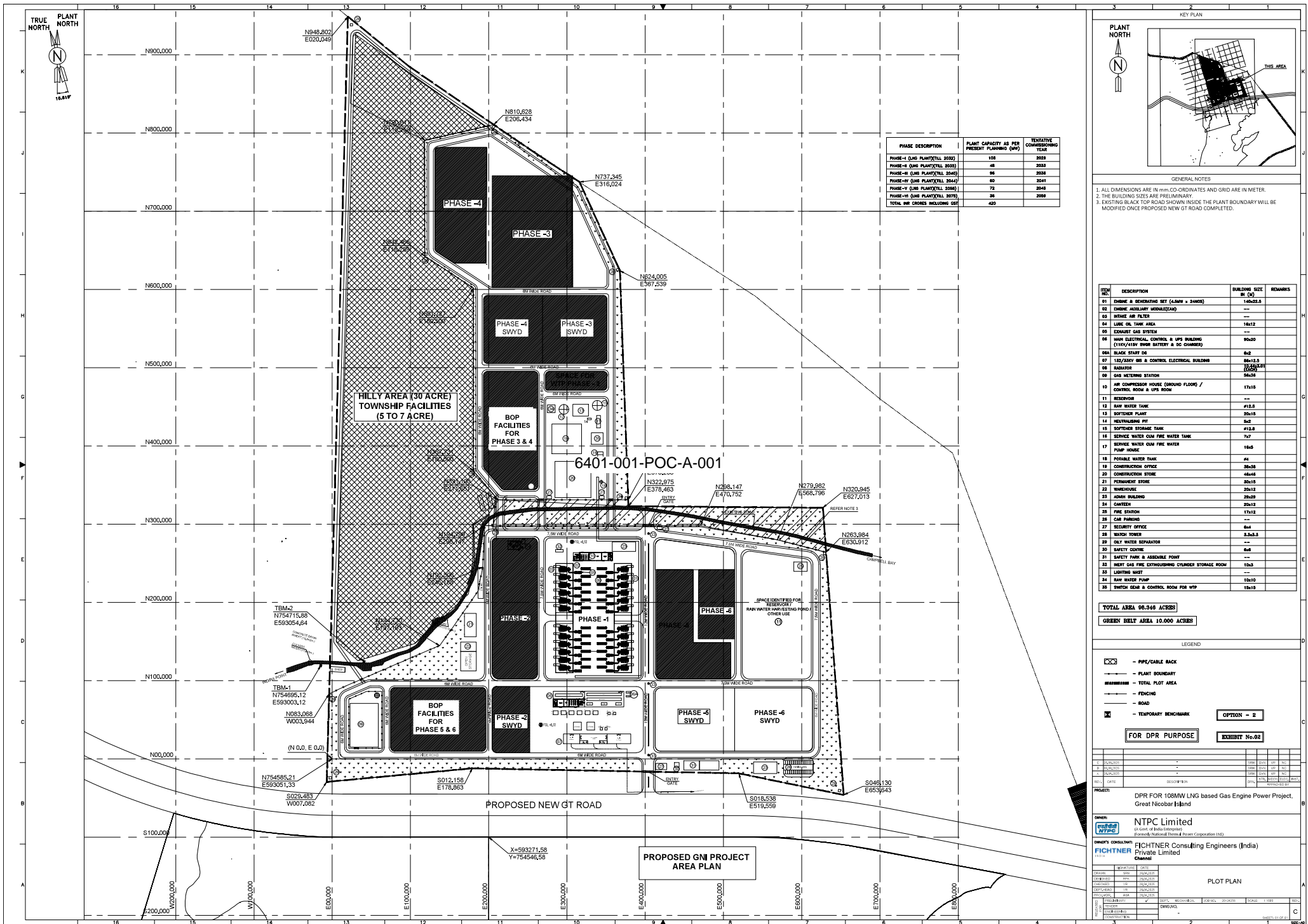
- LEGEND
- PIPE/CABLE BACK
 - PLANT BOUNDARY
 - TOTAL PLOT AREA
 - FENCING
 - ROAD
 - TEMPORARY BENCHMARK
- FOR DPR PURPOSE

PROJ: DPR FOR 108MW LNG based Gas Engine Power Project, Great Nicobar Island

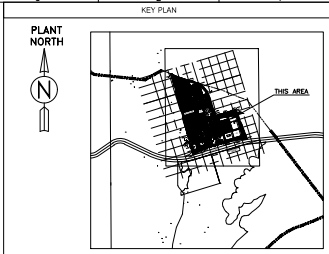
OWNER: NTPC Limited

OWNER'S CONSULTANT: FICHTNER Consulting Engineers (India) Private Limited

GENERAL LAYOUT PLAN (CAPACITY - 12MW)



PHASE DESCRIPTION	PLANT CAPACITY AS PER PRESENT PLANNING (MW)	TERMINATING CONVERSION YEAR
PHASE-1 (LNG PLANT/CELL 2002)	108	2008
PHASE-2 (LNG PLANT/CELL 2003)	48	2008
PHASE-3 (LNG PLANT/CELL 2004)	96	2008
PHASE-4 (LNG PLANT/CELL 2004)	60	2008
PHASE-5 (LNG PLANT/CELL 2006)	72	2008
PHASE-6 (LNG PLANT/CELL 2007)	36	2008
TOTAL LNG CRYOCHES INCLUDING GBT	420	



GENERAL NOTES
 1. ALL DIMENSIONS ARE IN mm CO-ORDINATES AND GRID ARE IN METER.
 2. THE BUILDING SIZES ARE PRELIMINARY.
 3. EXISTING BLACK TOP ROAD SHOWN INSIDE THE PLANT BOUNDARY WILL BE MODIFIED ONCE PROPOSED NEW GT ROAD COMPLETED.

ITEM NO.	DESCRIPTION	BUILDING SIZE IN (M)	REMARKS
01	ENGINE & GENERATING SET (LSM & BANS)	14x25.5	
02	ENGINE AUXILIARY MONITORING	---	
03	INTAKE AIR FILTER	---	
04	LARGE OIL TANK AREA	18x12	
05	EXHAUST GAS SYSTEM	---	
06	MAIN ELECTRICAL CONTROL & UPS BUILDING (110V/415V BROWN BATTERY & DC CHARGER)	90x20	
06A	BLACK START DS	5x2	
07	152/30KV GIS & CONTROL ELECTRICAL BUILDING	96x13.5	
08	RADIATOR	17x15	
09	GAS METERING STATION	5x2	
10	400 COMPRESSOR HOUSE (GROUND FLOOR) / CONTROL ROOM & UPS ROOM	17x15	
11	RESERVOIR	---	
12	RAW WATER TANK	41x3.5	
13	SOFTENER PLANT	25x15	
14	NEUTRALISING PIT	5x2	
15	SOFTENER STORAGE TANK	41x3.5	
16	SERVICE WATER CUM FINE WATER TANK	7x7	
17	SERVICE WATER CUM FINE WATER PUMP HOUSE	16x5	
18	POTABLE WATER TANK	4x4	
19	CONSTRUCTION OFFICE	26x26	
20	CONSTRUCTION STORE	40x25	
21	PERMANENT STORE	25x15	
22	WAREHOUSE	25x12	
23	ADMIN BUILDING	25x25	
24	CANTEEN	25x15	
25	FIRE STATION	17x12	
26	CAR PARKING	---	
27	SECURITY OFFICE	8x4	
28	WATER TOWER	5.3x3.5	
29	OILY WATER SEPARATOR	---	
30	SAFETY CENTRE	6x6	
31	SAFETY HALL & ASSEMBLY POINT	---	
32	HEAT GAS FIRE EXTINGUISHING CYLINDER STORAGE ROOM	15x5	
33	LIGHTING MAST	---	
34	RAW WATER PUMP	10x10	
35	SWITCH GEAR & CONTROL ROOM FOR WTP	15x15	

TOTAL AREA 98.946 ACRES
 GREEN BELT AREA 10.000 ACRES

LEGEND

- PIPE/CABLE BACK
- PLANT BOUNDARY
- TOTAL PLOT AREA
- FENCING
- ROAD
- TEMPORARY BENCHMARK

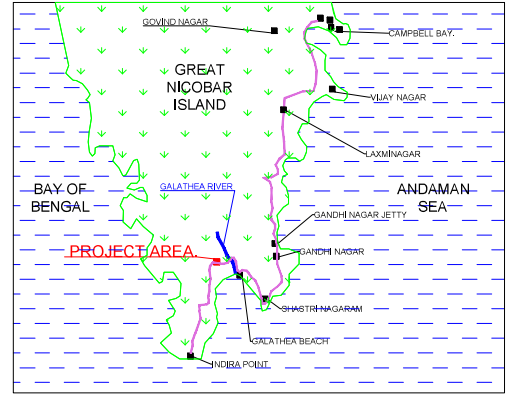
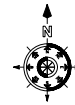
OPTION - 2

FOR DPR PURPOSE

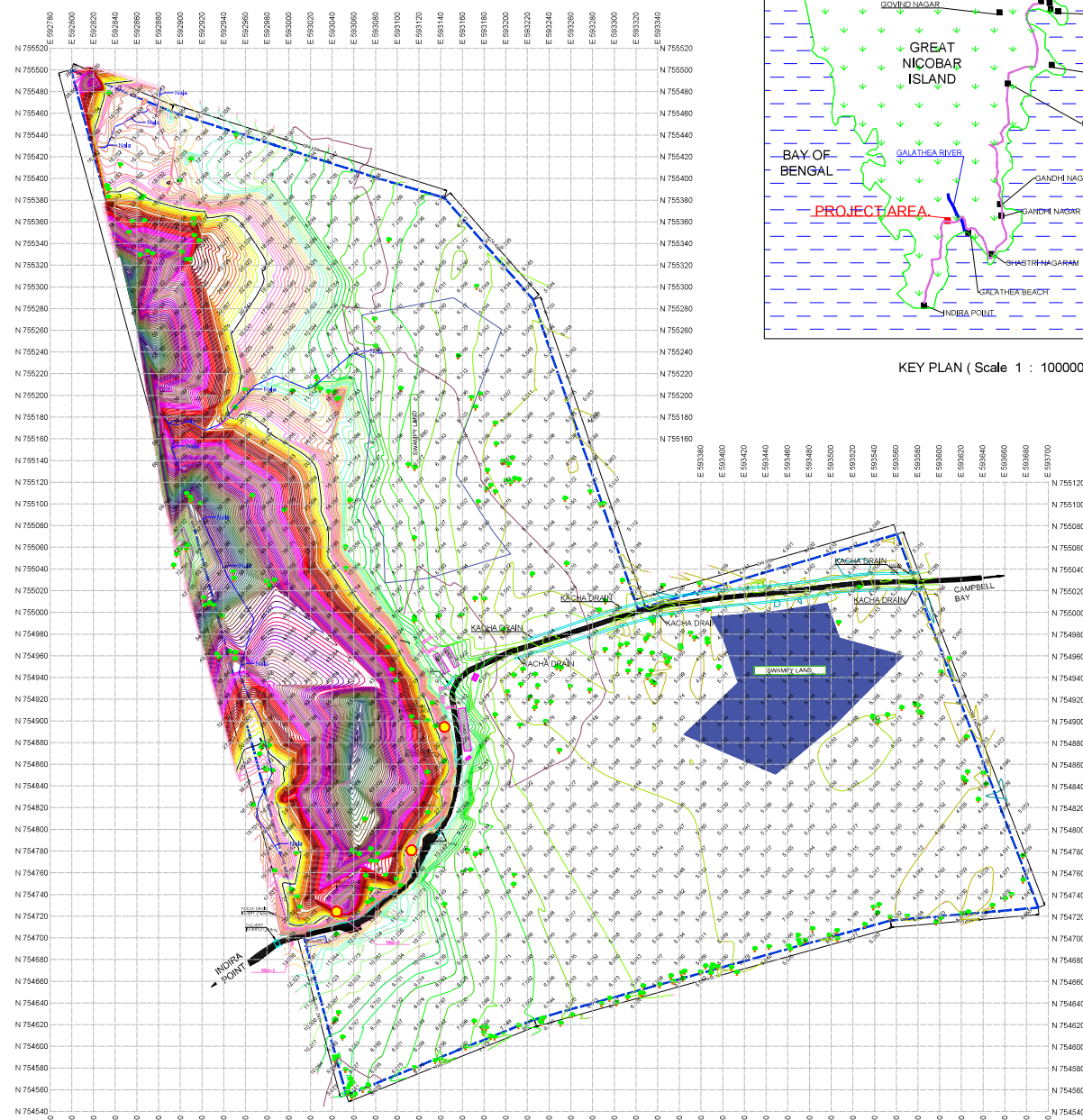
EXHIBIT No.02

REV.	DATE	DESCRIPTION	BY	CHECKED	DATE
1	24/04/2023	ISSUED FOR PERMIT	---	---	---
2	24/04/2023	REVISED	---	---	---
3	24/04/2023	REVISED	---	---	---
4	24/04/2023	REVISED	---	---	---
5	24/04/2023	REVISED	---	---	---
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7	24/04/2023	REVISED	---	---	---
8	24/04/2023	REVISED	---	---	---
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63	24/04/2023	REVISED	---	---	---
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65	24/04/2023	REVISED	---	---	---
66	24/04/2023	REVISED	---	---	---
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68	24/04/2023	REVISED	---	---	---
69	24/04/2023	REVISED	---	---	---
70	24/04/2023	REVISED	---	---	---
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76	24/04/2023	REVISED	---	---	---
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93	24/04/2023	REVISED	---	---	---
94	24/04/2023	REVISED	---	---	---
95	24/04/2023	REVISED	---	---	---
96	24/04/2023	REVISED	---	---	---
97	24/04/2023	REVISED	---	---	---
98	24/04/2023	REVISED	---	---	---
99	24/04/2023	REVISED	---	---	---
100	24/04/2023	REVISED	---	---	---

TOPOGRAPHICAL PLAN OF PROJECT SITE (Scale 1 : 2000)



KEY PLAN (Scale 1 : 100000)



PILLAR DETAILS:-

PILLAR NO.	EASTING	NORTHING	ELEVATION
BM1	593141,647	754919,883	11,000
BM2	593124,666	754964,074	9,311
RP1	593142,356	754917,296	11,434
RP2	593123,573	754966,488	9,668

BM = Benchmark Pillar
RP = Reference Pillar

TBM DETAILS:-

TBM NO.	EASTING	NORTHING	ELEVATION
TBM 1	593003,129	754895,123	14,206
TBM 2	593054,642	754715,882	15,033

NOTE:-

1. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE STATED.
2. TOTAL AREA OF LAND = 3,97,989.201 SQ.M.
= 98.346 ACRES.
3. CONTOUR INTERVAL = 0.500 m.
4. TOTAL SURVEYED AREA IS COVERED WITH BUSH/SHRUBS

SPECIAL NOTES (RFQ)

1	ESTABLISHING & CONSTRUCTING BENCHMARK & REFERENCE PILLAR	COMPLETED AT SITE
2	SPOT LEVELING	20 M INTERVAL
3	CROSS SECTION OF RIVER	NO RIVER FOUND
4	KHASRA / MOUZA DETAILS	FOREST LAND
5	LAND USE	FOREST LAND
6	BENCHMARK ESTABLISHMENT	DONE BY DGPS (NO BENCHMARK FOUND NEAR BY)
7	BENCHMARK / REFERENCE PILLAR ON DRAWING	SHOWN IN DRAWING
8	ALL NATURAL / ARTIFICIAL FEATURES	SHOWN IN DRAWING
9	HILLS / VALLEYS PLOTTED ON MAPS BY CONTOUR	SHOWN IN DRAWING
10	CONTOUR INTERVAL	0.5 M
11	TREE DETAILS	PRESENTED SEPARATELY
12	KEY PLAN	PRESENTED
13	AGRICULTURAL SURVEY	NO FARM LAND, ALL FOREST LAND
14	POPULATION SURVEY	NO OFFICIAL HUMAN INHABITANTS

LEGEND

SL.NO.	DESCRIPTION	SYMBOL
1	SHED	
2	BOUNDARY LINE	
3	BLACK TOP ROAD	
4	DRAIN	
5	TREE	
6	NALA	
7	SWAMPY LAND	
8	GRID LINE	
9	CONTOUR LINE	
10	CULVERT	
11	RESERVOIR	
12	ROCK EXPOSURES	

FOR DPR PURPOSE

88887 8844-94

Scale 1 : 2000

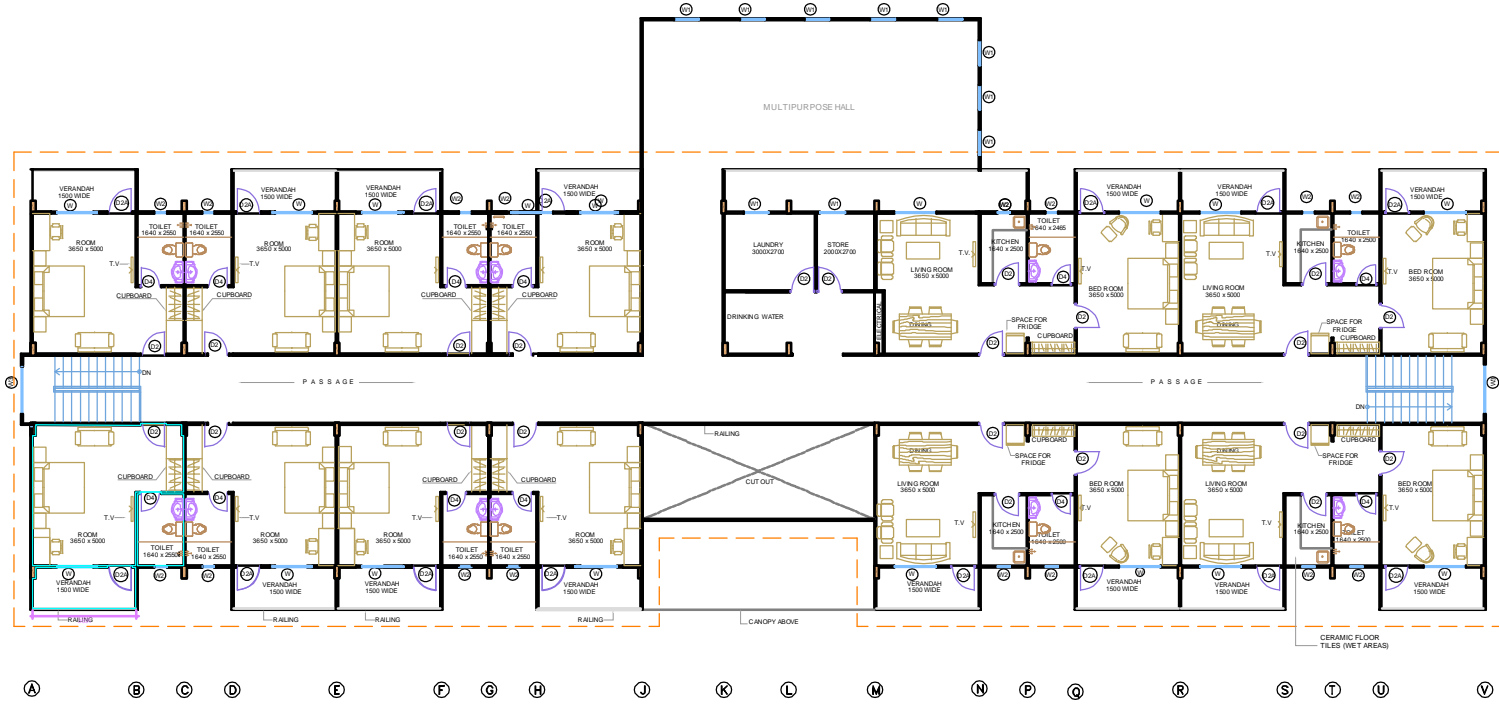


REV.	DATE	DESCRIPTION	DRN.	STR.	MED.	ELEC.	INST.	APPROVED BY
B	23.05.2025	ISSUED FOR APPROVAL						GPP
A	30.04.2025	ISSUED FOR APPROVAL						
PROJECT: DPR for 108MW LNG based Gas Engine Power Project, Great Nicobar Island								
TITLE: TOPOGRAPHICAL PLAN								
OWNER: NTPC Limited (A Govt. of India Enterprise) (Formerly National Thermal Power Corporation Ltd.)								
OWNER'S CONSULTANT: Fichtner Consulting Engineers (India) Private Limited Chennai								
Sub-Contractor: Geosolution Proservices Private Limited Kolkata								
SIGNATURE DATE								
DRAWN	YM	20.04.2025						
DESIGNED	GVN	20.04.2025						
CHECKED	GVN	20.04.2025						
DEPT. HEAD	VR	20.04.2025						
PROJ. MGR.	ASA	20.04.2025						
RELEASED FOR:	PRELIMINARY		DEPT.	DEPARTMENT	JOB NO.	20124256	SCALE:	1 : 2000
	ENGINEERING				DWG. NO.	6401-001-POC-A-003		
	CONSTRUCTION							
SHEET 01								

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SIDE



FRONT

FIRST FLOOR PLAN

DOOR SCHEDULE

TYPE	MARK	WIDTH	HEIGHT	TOP LEVEL
ANODISED ALUMINIUM GLAZED DOOR AS/SPEC.	D1	1800	2550	2550
	D2	900	2100	2100
FLUSH DOOR AS/SPEC.	D3A	900	2100	2100
	D4	750	2100	2100
	D5	750	2100	2100

WINDOW SCHEDULE

TYPE	MARK	WIDTH	HEIGHT	SILL LEVEL	TOP LEVEL
ANODISED ALUMINIUM GLAZED WINDOW AS/SPEC.	W	1500	1200	900	2100
	W1	900	1200	900	2100
	W2	800	900	1200	2100
	W3	1350	2550	100	2550

i f j : k t u k		जोएनआई गैस इंजन पावर प्रोजेक्ट चरण-1 (108 MW)	
PROJECT		GNI GAS ENGINE POWER PROJECT PHASE-1 (108 MW)	

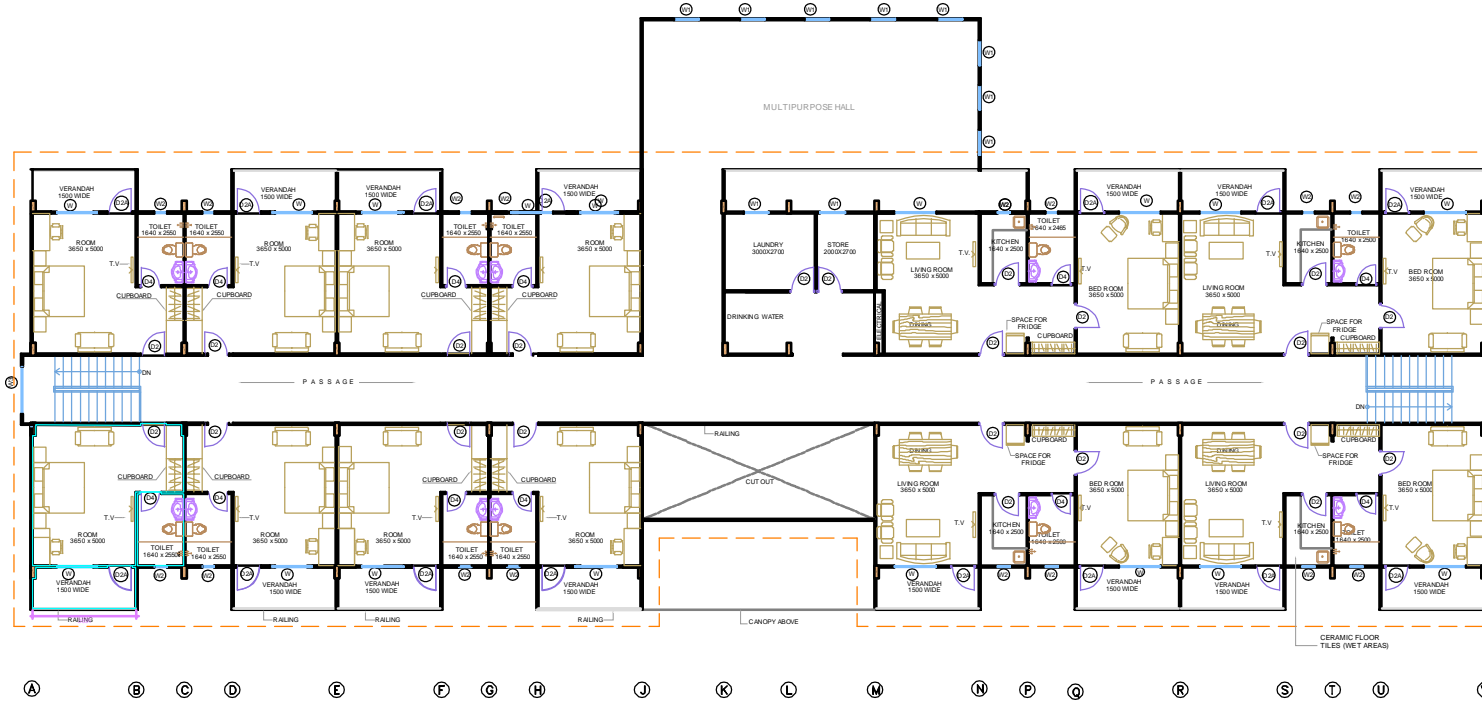
TITLE		BACHELOR & SUITE ACCOMMODATION PRE ENGINEERED STRUCTURE FIRST FLOOR PLAN	
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RA		RELEASED FOR TENDER PURPOSE ONLY.				SAPARNA				ANL		03.01.2025		FIRST FLOOR PLAN			
REV.NO.	DESCRIPTION				DRAWN	DESIGN	CHKD.	MECH.	ELECT.	CIVIL	C & I	APPD	DATE	SIZE	SCALE	DRG. NO.	REV. NO.
								CLEARED BY						A1	1:100	6401-001-POC-A-004	RA

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SIDE



FRONT


FIRST FLOOR PLAN

DOOR SCHEDULE

TYPE	MARK	WIDTH	HEIGHT	TOP LEVEL
ANODISED ALUMINIUM GLAZED DOOR AS/SPEC.	D1	1800	2550	2550
	D2	900	2100	2100
FLUSH DOOR AS/SPEC.	D3A	900	2100	2100
	D4	750	2100	2100
	D5	750	2100	2100

WINDOW SCHEDULE

TYPE	MARK	WIDTH	HEIGHT	BILL LEVEL	TOP LEVEL
ANODISED ALUMINIUM GLAZED WINDOW AS/SPEC.	W	1500	1200	900	2100
	W1	900	1200	900	2100
	W2	800	900	1200	2100
	W3	1350	2550	100	2550

**NTPC**

एन टी सी लिमिटेड
NTPC Limited
(A Govt. of India Enterprise)

i f j : k t u k

जीएनआई गैस इंजन पावर प्रोजेक्ट चरण-1
(108 MW)

PROJECT

GNL GAS ENGINE POWER PROJECT PHASE-1
(108 MW)

TITLE BACHELOR & SUITE ACCOMMODATION
PRE ENGINEERED STRUCTURE
FIRST FLOOR PLAN

RA		RELEASED FOR TENDER PURPOSE ONLY.			SUPARNA							ANL.	03.01.2025	THE ENGINEER'S STRUCTURE FIRST FLOOR PLAN			
REV.NO.	DESCRIPTION			DRAWN	DESIGN	CHKD.	MECH.	ELECT.	CIVIL	C & I	APPD	DATE	SIZE	SCALE	DRG. NO.	REV. NO.	
							CLEARED BY						A1	1:100	6401-001-POC-A-005	RA	

(A) (B) (C) (D) (E) (F) (G) (H) (J) (K) (L) (M) (N) (P) (Q) (R)



(A) (B) (C) (D) (E) (F) (G) (H) (J) (K) (L) (M) (N) (P) (Q) (R)



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[illegible]

1. ALL THE DIMENSIONS ARE IN MM & LVL. ARE IN METERS.
2. DRAWING SHALL NOT BE SCALED ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.
3. ANY ERROR OR DISCREPANCY IN THE DRAWING IS TO BE BROUGHT TO THE NOTICE OF ENGINEER-IN-CHARGE.
4. THIS DRAWING SHALL BE READ ALONG WITH RESPECTIVE STRUCTURAL DRAWINGS AND OTHER DETAIL ARCHITECTURAL DRAWINGS.
5. THIS DRAWING SHALL NOT BE USED OTHER THAN THE PURPOSES MARKED ISSUED.

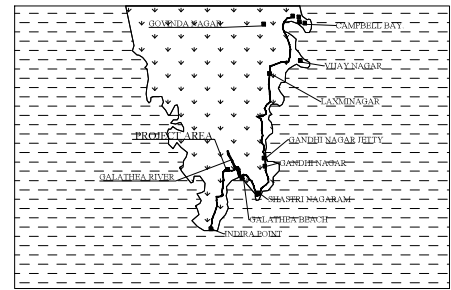
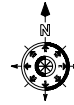
SCHEDULE OF DOORS & WINDOWS			
S.No	SIZE	SILL LVL.	DESCRIPTION
D1	1800 x 2550	-	AL. GLAZED DOOR
D2	900 x 2100	-	AL. FRAMED SOLID FLUSH DOOR
D2A	900 x 2100	-	AL. FRAMED SOLID FLUSH DOOR
D4	750 x 2100	-	AL. FRAMED SOLID FLUSH DOOR
W	1350 x 1200	900	AL. FRAMED SLIDING WINDOW
W1	900 x 1200	900	AL. FRAMED SLIDING WINDOW
W2	450 x 900	1200	AL. FIX LOUVERED VENTILATOR
W3	1350 x 2550	100	AL. FRAMED SLIDING WINDOW

RA	RELEASED FOR TENDER PURPOSE ONLY.		SUPARNA						ANIL	03.01.20
REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	MECH	ELECT.	CIVIL	C & I	APPO	DATE
					CLEARED BY					

			
गी. गै. पावर प्रोजेक्ट PROJECT		जीएनआई गैस इंजन पावर प्रोजेक्ट चरण-1 (108 MW) GNI GAS ENGINE POWER PROJECT PHASE-I (108 MW)	
TITLE		BACHELOR & SUITE ACCOMMODATION PRE ENGINEERED STRUCTURE ELEVATIONS	
SIZE	SCALE	DRG. NO.	REV. NO.
A1	1:100	6401-001-POC-A-006	RA

GEOLOGICAL MAP OF PROJECT SITE

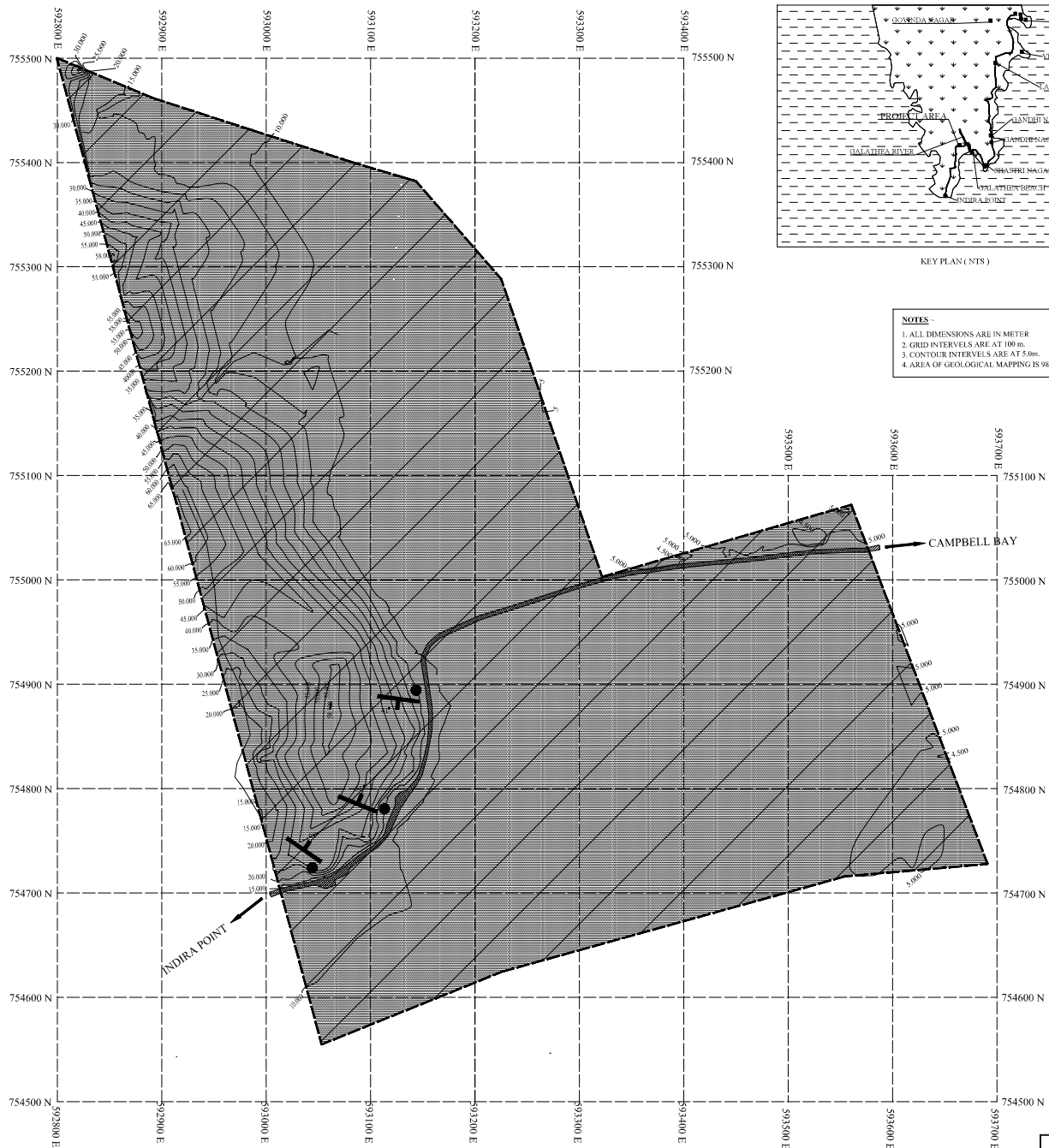
(Scale 1 : 2000)



KEY PLAN (NTS)

NOTES

1. ALL DIMENSIONS ARE IN METER
2. GRID INTERVALS ARE AT 100 m.
3. CONTOUR INTERVALS ARE AT 5.0m.
4. AREA OF GEOLOGICAL MAPPING IS 98.301 ACRES.



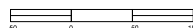
FOR DPR PURPOSE

EXHIBIT No.05

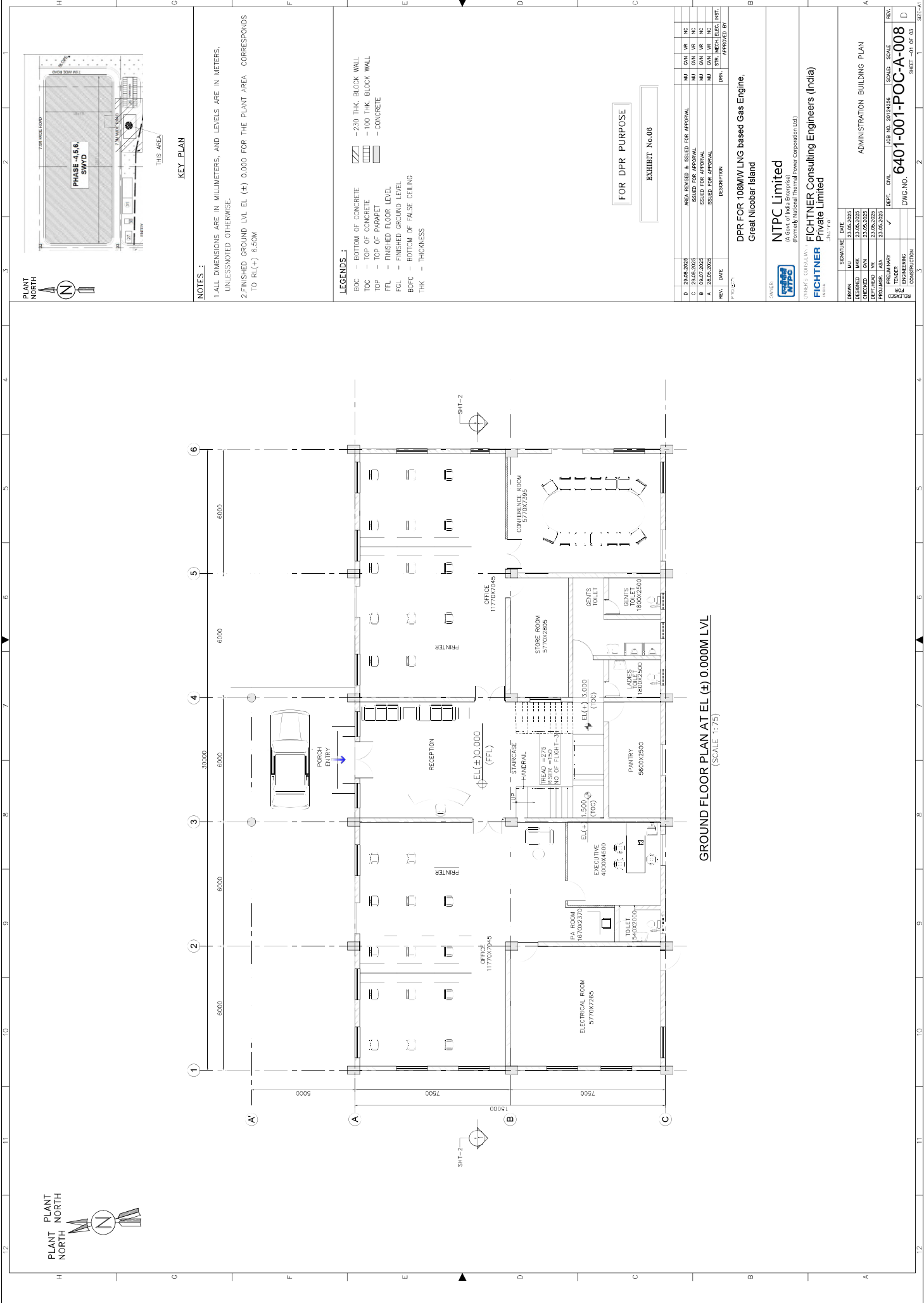
SPECIAL NOTES (RFQ)		
1	ROCK OUTCROPS	SHOWN IN THE GEOLOGICAL MAP
2	JOINT PATTERNS / CONDITIONS	NOT CONSPICUOUS
3	FAULTS / FOLDS	NOT FOUND
4	DIP / STRIKE	SHOWN IN THE GEOLOGICAL MAP
5	LITHOLOGICAL CLASSIFICATION	SEDIMENTARY ROCK (ANDAMAN FLYSCH)
6	GEO-MORPHOLOGY	MODERATE HILLS FLANKED BY NARROW COAST
7	WEATHERING	HIGHLY WEATHERED ROCKS
8	SOIL COVER	SHOWN IN THE GEOLOGICAL MAP
9	GROUND WATER TABLE	NEAR SURFACE

LEGENDS	
	ANDAMAN FLYSCH (ALTERNATE SEQUENCE OF SANDSTONE-SILTSTONE-SHALE)
	MANGROVE-SWAMPY SOIL
	STRIKE & DIP OF BEDDING
	ROCK EXPOSURES
	ROAD
	PROJECT AREA
	CONTOUR LINE
	GRID LINE
	NALA

Scale 1 : 2000



A		29.05.2022		ISSUED FOR APPROVAL		DPP	
REV.	DATE	DESCRIPTION				DRN.	STR. MECH. ELEC. INST.
PROJECT: DPR For 108MW LNG based Gas Engine Power Project, Great Nicobar Island							
TITLE: GEOLOGICAL MAP							
OWNER: NTPC Limited (A Govt. of India Enterprise) (Formerly National Thermal Power Corporation Ltd.)							
OWNER'S CONSULTANT: Fichtner Consulting Engineers (India) Private Limited Chennai							
Sub-vendor: Gesolution Proservices Private Limited Kolkata							
DRAWN		MU		DATE		29.05.2022	
DESIGNED		GVR		DATE		29.05.2022	
CHECKED		GVR		DATE		29.05.2022	
DEPT. HEAD		VR		DATE		29.05.2022	
PROJECT MGR.		ASA		DATE		29.05.2022	
TENDER		ENGINEERING		CONSTRUCTION		DEPT. CIVIL	
DWG. NO.		6401-001-POC-A-007		SCALE		1 : 2000	
SHEET		A1		REV.		A	



GROUND FLOOR PLAN AT EL (+) 0.000M LVL
(SCALE 1:7.5)

NOTES :

1. ALL DIMENSIONS ARE IN MILLIMETERS, AND LEVELS ARE IN METERS, UNLESS NOTED OTHERWISE.
2. FINISHED GROUND LVL (±) 0.000 FOR THE PLANT AREA CORRESPONDS TO RL(±) 6.50M

KEY PLAN

LEGENDS :

- BOC - BOTTOM OF CONCRETE
- TOC - TOP OF CONCRETE
- TOP - TOP OF PARAPET
- FFL - FINISHED FLOOR LEVEL
- FGL - FINISHED GROUND LEVEL
- BOFC - BOTTOM OF FALSE CEILING
- THK - THICKNESS

- ~230 THK. BLOCK WALL
- ~100 THK. BLOCK WALL
- CONCRETE

FOR DPR PURPOSE

EXHIBIT No.08

REV.	DATE	DESCRIPTION	BY	CHKD	APPD
D	28.08.2025	ISSUED FOR APPROVAL	MJ	ON	NC
C	28.08.2025	ISSUED FOR APPROVAL	MJ	ON	NC
B	09.07.2025	ISSUED FOR APPROVAL	MJ	ON	NC
A	28.05.2025	ISSUED FOR APPROVAL	MJ	ON	NC

DPR FOR 108MW LNG based Gas Engine,
Great Nicobar Island

NTPC Limited
NTPC Limited
NTPC Limited
NTPC Limited

FOR APPROVAL

FICHTNER Consulting Engineers (India) Private Limited

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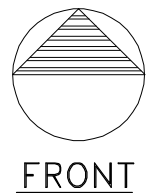
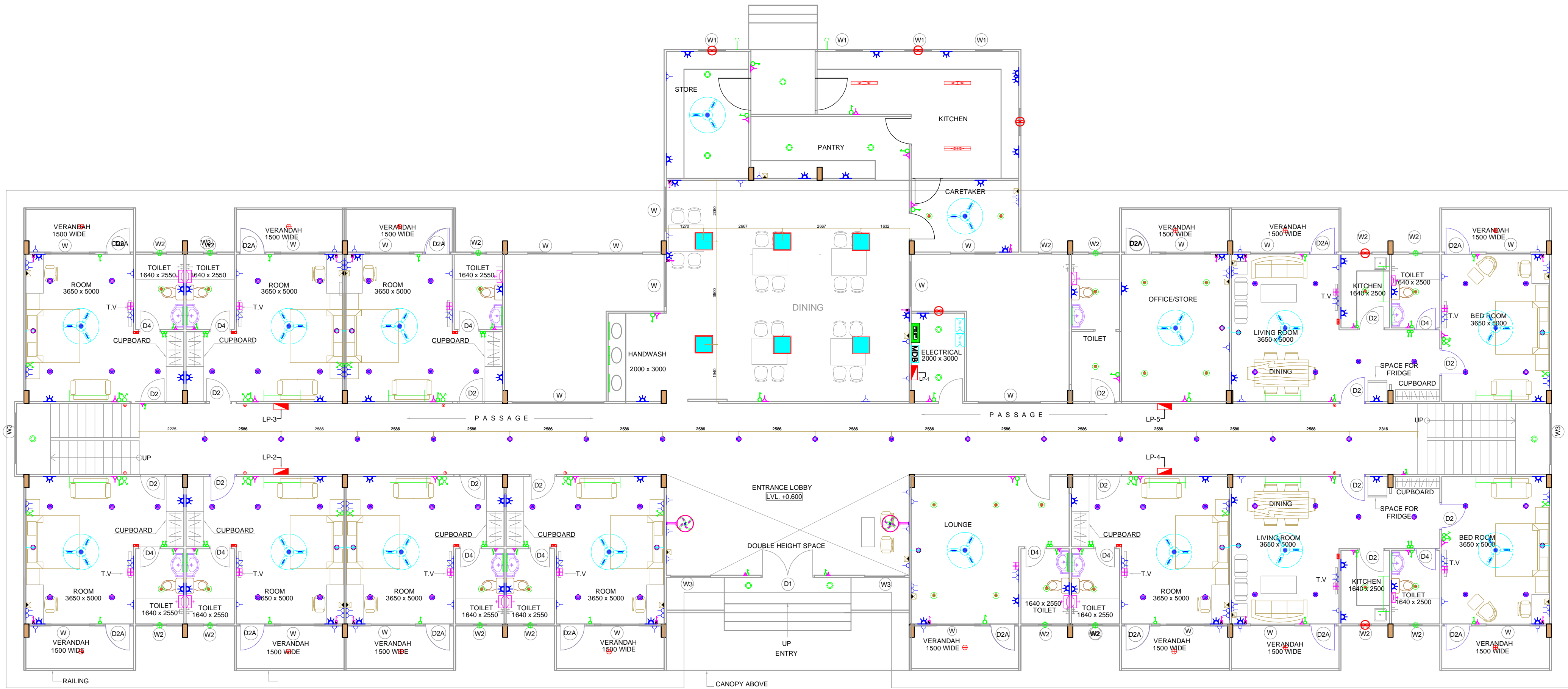
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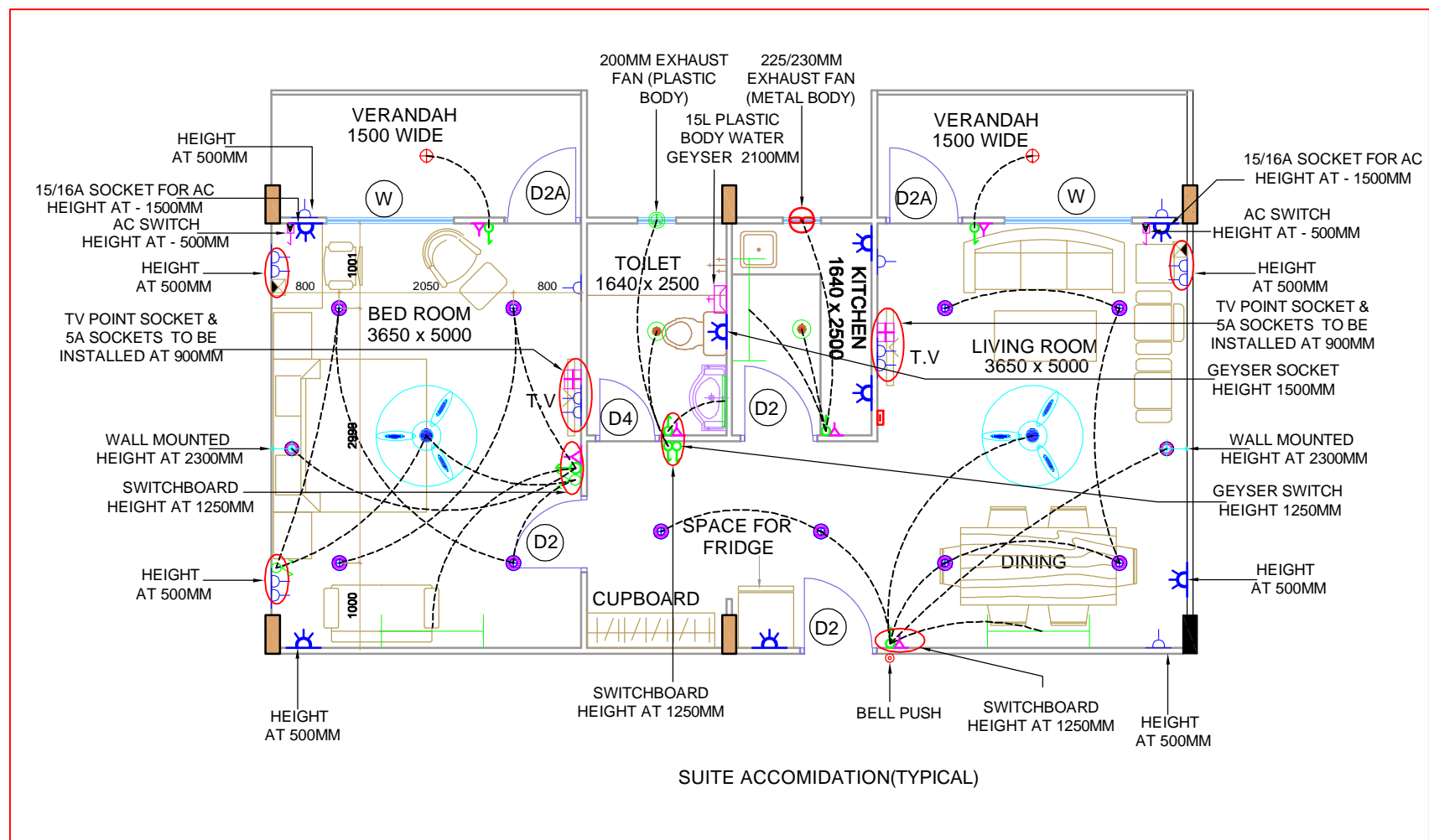
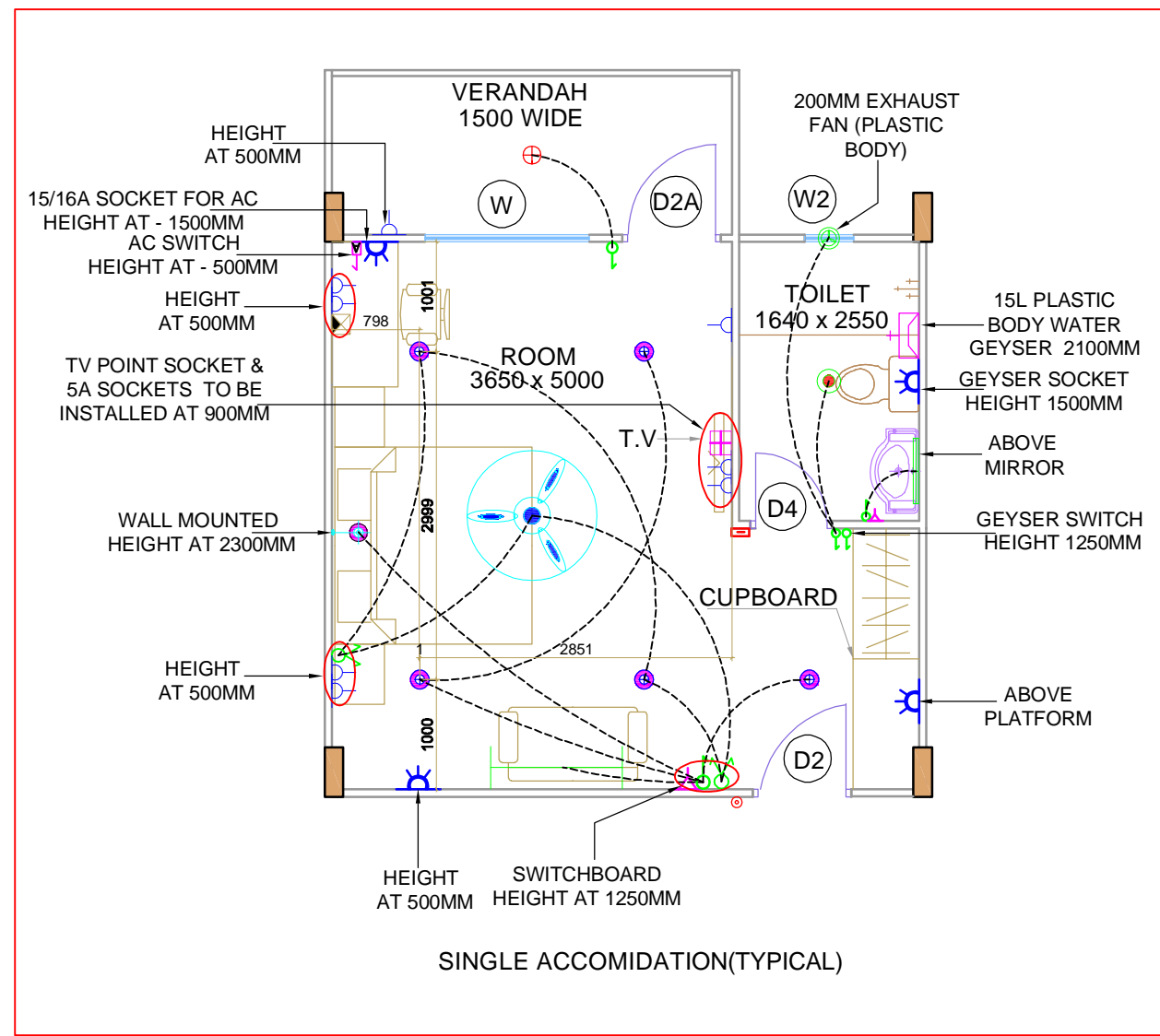
8031-500-TOE-A-101(RA)



GROUND FLOOR PLAN

NOTE:-

1. WIRING FOR LIGHT, FAN, EXHAUST FAN, 5/15 PLUG POINT ETC. SHALL BE DONE AS PER CPWD TECHNICAL SPECIFICATION.
2. THE SIZE OF DIFFERENT SWITCH BOARD SHALL BE DECIDED BY TOTAL LOAD CONNECTED AS WELL AS TOTAL NUMBER OF POINTS RESPECTIVELY.
3. CONCEALED CONDUIT WIRING SHALL BE ADOPTED.
4. CIRCUIT DIAGRAM & CONDUIT LAYOUT SHALL BE DEVELOPED BY ELECTRICAL CONTRACTOR AND SHALL BE APPROVED BY THE OWNER'S SITE ENGINEER-IN-CHARGE.
5. MOUNTING HEIGHT OF LUMINARIES AND THEIR ACCESSORIES FROM THE FINISHED FLOOR LEVEL SHALL BE AS PER C.P.W.D. SPECIFICATIONS.
6. THE LED LIGHT FITTINGS SHALL BE PROVIDED WITH NECESSARY DRIVER.
7. ANY DOUBT OR MISMATCHING BETWEEN DRAWING AND TECHNICAL SPECIFICATION HAS TO BE BROUGHT TO OWNER'S NOTICE BY THE BIDDER FOR CLARIFICATION BEFORE AWARD OF THE PACKAGE.
8. THE LOCATION OF METER BOARD, LIGHTING PANEL, SWITCHBOARDS, FIXTURES, FANS ETC. MAY BE MODIFIED BASED ON OWNERS SITE ENGINEER-IN-CHARGE APPROVAL.
9. SEPARATE CONDUIT SHALL BE LAID FOR TELEPHONE, TV, SUB-MAIN, CIRCUIT, AND POINT WIRING.
10. WIRING FOR LIGHTING CIRCUIT SHALL BE DONE WITH 2X2.5 SQMM+1X2.5 SQMM FRLS PVC WIRES PER CIRCUIT IN STEEL CONDUIT.
11. WIRING FOR 5A SOCKET OUTLETS SHALL BE DONE WITH 2X1.5+1X1.5 SQMM FRLS PVC WIRE IN STEEL CONDUIT.
12. WIRING FOR PRIMARY 15A SOCKET OUTLET SHALL BE DONE WITH 2X4+1X4 SQMM FRLS PVC INSULATED COPPER WIRES AND SECONDARY SOCKET MAY BE CONNECTED WITH 2X2.5+1X2.5 SQMM FRLS PVC COPPER WIRES.
13. WIRING FOR AC POINTS-20A MODULAR SOCKET OUTLETS SHALL BE DONE WITH 2X4 SQMM+1X4 SQMM FRLS PVC IN STEEL CONDUIT.
14. INDIVIDUAL ROOMS SHALL HAVE PROVISION OF TELEPHONE & TV . AS SUCH CONDUITING ALONG WITH WIRING SHALL BE ROUTED FROM THE INDIVIDUAL ROOMS UPTO ELECTRICAL ROOMS & TERRACE RESPECTIVELY .
15. ALL DBS SHOULD BE WITH NECESSARY PROTECTED LIKE OVER CURRENT, SHORT CIRCUIT & EARTH LEAKAGE.
16. STABILIZER FOR ALL AC UNITS SHALL BE INSTALLED IN BALCONY, HOWEVER AC POINT SOCKET SHALL BE INSTALLED IN THE ROOM W.R.T. DRAWING.

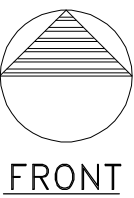


RA	RELEASED FOR TENDER PURPOSE ONLY.	S.K	V.K	CHKD.	MECH.	ELECT.	CIVIL	C & I	APPD	DATE
REV.NO.	DESCRIPTION	DRAWN	DESIGN							

LEGEND				
SL.No	SYMBOL	DESCRIPTION	HEIGHT(MM)	
1		18- 20W LED LIGHT FIXTURE - 1200MM (Type: Wipro LL20-281-XXX-65AL1 Surya SLE BT 20 G1, Bajaj: BCLAB 20WH, Philips)	2300/WALL	
2		1X10- 12W LED LIGHT FIXTURE-600MM (Type: Philips BN 021 LED125 6500 PSU GR, Wipro LL20-111-XXX-65AL1or Surya SLE BT 10 IL, Bajaj)	ABOVE MIRROR	
3		36- 42W WEATHER PROOF LED LIGHT FIXTURE (Type: Bajaj - BIPC 40WLED, Philips WT201C LED445-6500 PSU L120, Wipro LE23-491-XXX-57-XX, Surya SLE WPL 36W)		
4		36- 40W RECESS MOUNTED LIGHT FIXTURE (2x2) (Type: Bajaj B2RSOL 36W WH or Philips RC380B LED365-6500 G5 36W WH or Wipro: CRC010R038HP57GL1 or Surya SLE D5 36 22R)		
5		12W LED CEILING MOUNTED LIGHT FIXTURE (Type: Bajaj: BGSLO Sleek Surface RD 12W WH LED or Surya ATHENA SLE DLS 12W XX RD or Wipro: LD06-151-XXX-40SMG1 or Philips SM250C LED125- 6500 PSU WH)	CEILING	
6		6W LED CEILING MOUNTED LIGHT FIXTURE (Type: Bajaj: BGSLO Sleek Surface RD 12W WH LED or Philips SM250C LED7S, Wipro: LD06-670-XXX-40SMG1, Surya: ATHENA SLE DLR 12W XX RD)	CEILING	
7		12W LED RECESS MOUNTED LIGHT FIXTURE (Type: Bajaj: BGSLO Sleek Recess RD 12W WH LED, Philips DN296B LED125-4000 PSU, Wipro: LD06-151-XXX-40-XX or Surya SLE DLR 12W RIVO RD XX)	RECESS	
8		6W LED RECESS MOUNTED LIGHT FIXTURE (Type: Philips DN295B LED6S, Wipro: LD06-670-XXX-40-XX, Surya: SLE DLR 6W RIVO RD XX, Bajaj)	RECESS	
9		1X7- 10W LED WALL MOUNTED LIGHT FIXTURE (Type: Jaquar JNL-CHR- WLRB0480SE2 / Philips / Wipro)	2300	
10		6- 10W LED BULK LIGHT FIXTURE (Type: Bajaj: BIBWP 10W LED, Philips : WT202W LED65 CW PSU S2 PC, Wipro: LW07-141-XXX-57-G1, Surya :SLE BLH 10W PLUS)	2400	
11		100W LED FLOOD LIGHT FIXTURE (Type: Bajaj: GLATT MT 120L WH PO SC SD or Philips BVP192 LED110 CW NB FG GR PSU or Wipro: LF20-122-060-57-G2 or Surya SLE FL 100W IP66 LMS NEO)	6000	
12		1200 MM SWEEP BEE 5 STAR RATED CEILING FAN WITH BLDC MOTOR(MAKE:Havells-Stealth Pro Neo Smart/Orient Electric-Aerolite)	CEILING	
13		400MM SWEEP WALL MOUNTED FAN WITH DOUBLE PULL CART (MAKE: Bajaj /Cr ompton/ Khaitan/Or ient)	2100	
14		EXHAUST FAN (200MM SWEEP) PLASTIC BODY (MAKE: Bajaj /Cr ompton/ Khaitan/Or ient)	CUT OUT LEV.	
15		EXHAUST FAN (225/230 MM SWEEP) METAL BODY (MAKE: Bajaj /Cr ompton/ Khaitan/Or ient)	CUT OUT LEV.	
16		SWITCH BOARD WITH SWITCHES(MODULAR TYPE)	1250	
17		TWO WAY SWITCH(MODULAR TYPE)	1250	
18		5A SOCKET OUTLET WITH SWITCH(MODULAR TYPE)	500	
19		5A SOCKET WITH SWITCH(ON EX.S/W)(MODULAR TYPE)	500/900/1250	
20		15/20A AC SWITCH(MODULAR TYPE)	500	
21		5/15A OR 5/20A SOCKET OUTLET WITH SWITCH(MODULAR TYPE)	100 ROOM/1100 AREA COUNTER, KITCHEN/1800 GYSEY, 17250 WASHING MACHINE/1800 AC	
22		15L PLASTIC BODY WATER GEYSER (5 STAR RATED)	2100	
23		TELEPHONE SOCKET(MODULAR TYPE)	500	
24		T.V. SOCKET(MODULAR TYPE)	900	
25		BELL PUSH(MODULAR TYPE)	1250	
26		CALL BELL(DING- DONG TYPE)	2100	
27		MAIN DISTRIBUTION BOARD	WALL MOUNTED	
28		METER DISTRIBUTION BOARD	WALL MOUNTED	
29		LIGHTING PANEL	1500	
30		TELEPHONE DB	1500	

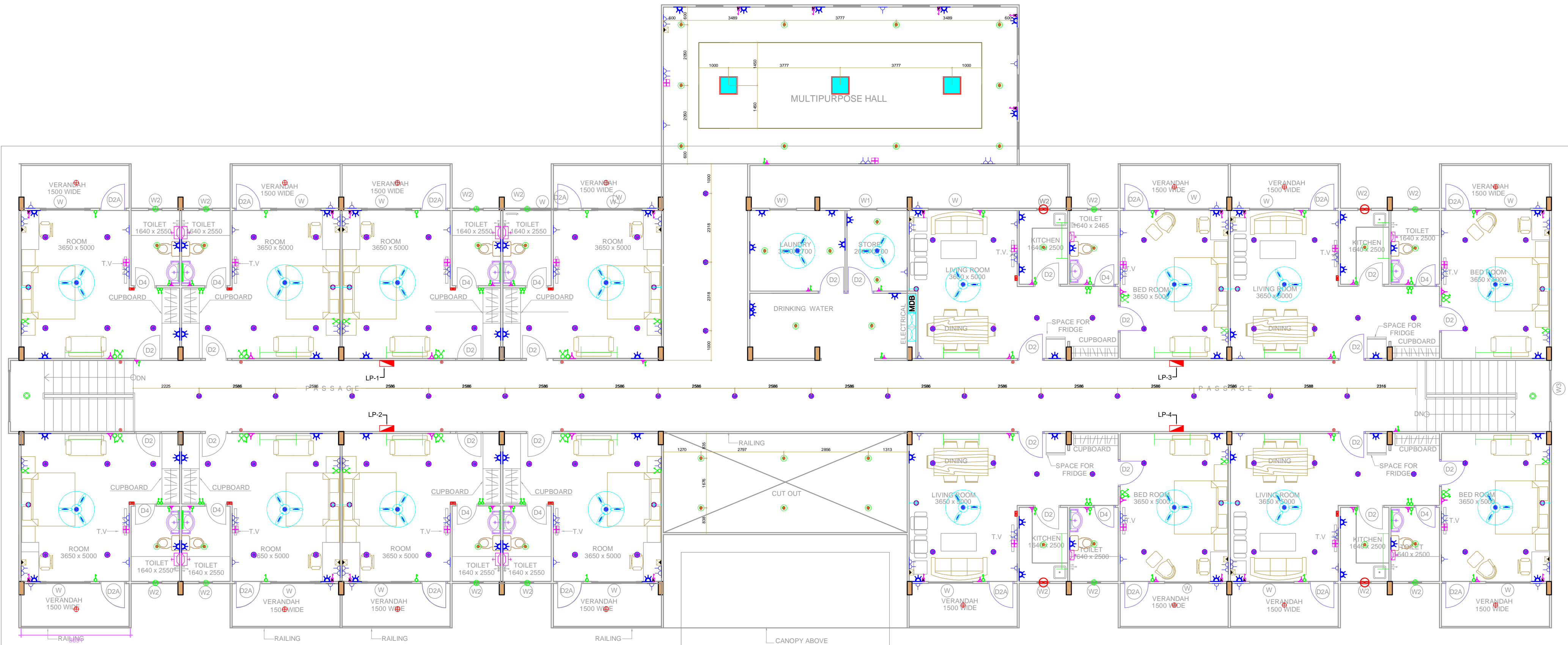
		एन टी सी लिमिटेड (एन सी ई सी 2004) NTPC Limited (A Govt. of India Enterprise)	
i fj; kt uk		GNI GAS ENGINE POWER PROJECT PHASE-I	
PROJECT		108 MW	
TITLE		BACHELOR & SUITE ACCOMMODATION PRE ENGINEERED STRUCTURE GROUND FLOOR ELECTRICAL LAYOUT PLAN	
SIZE	SCALE	DRG. NO.	REV. NO.
A1	NTS	6401-500-TOE-A-101	RA

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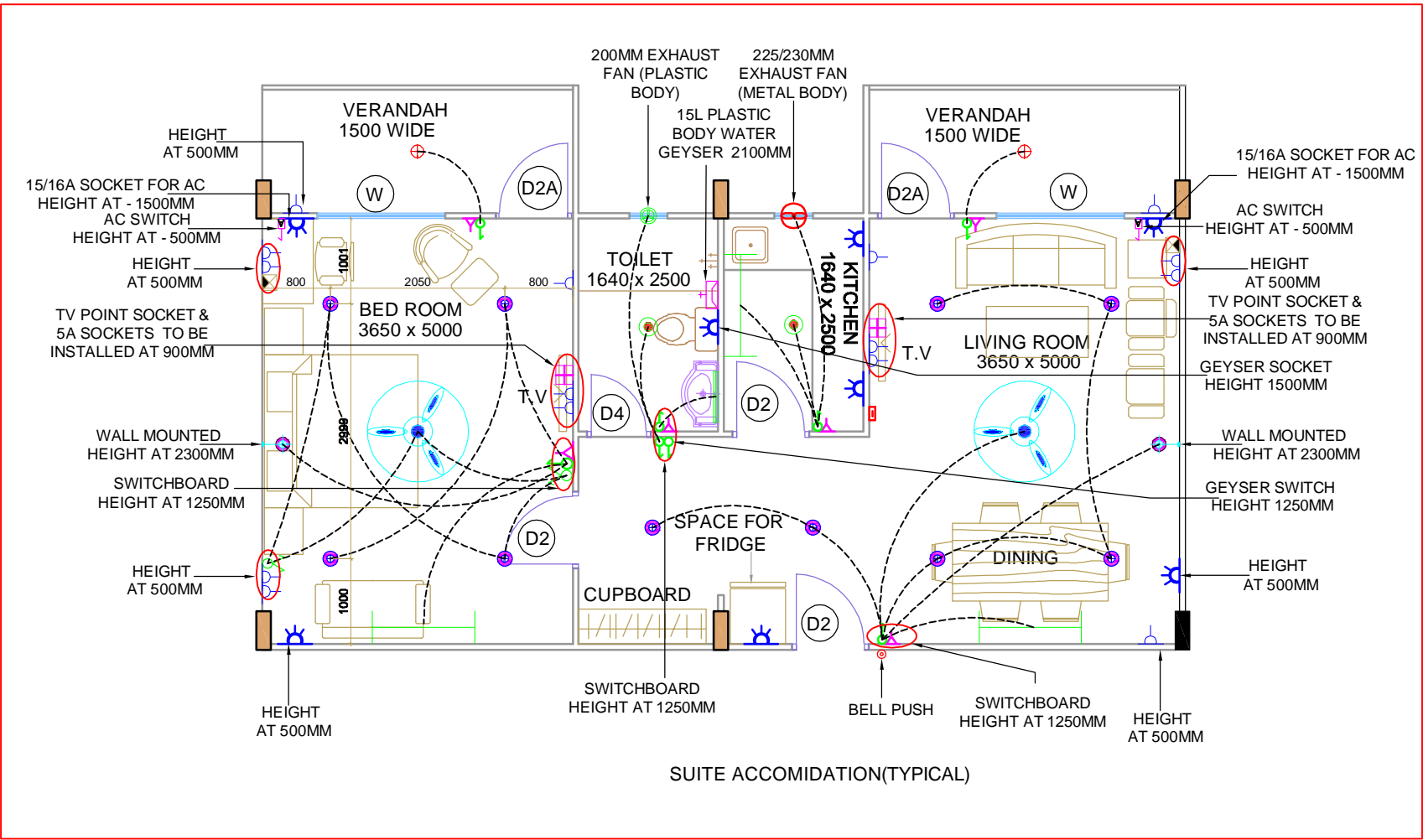
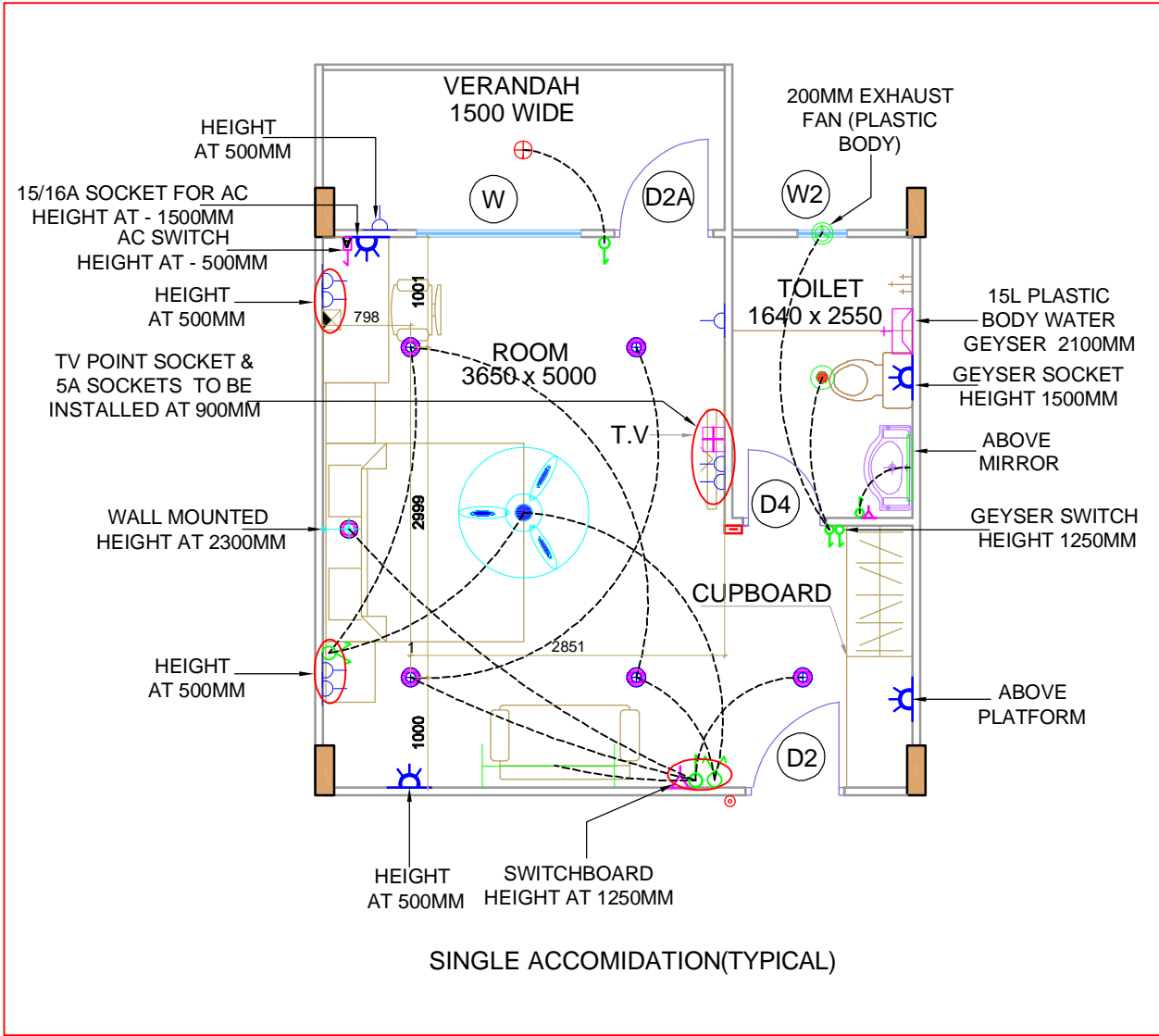


FIRST FLOOR PLAN

8031-500-TOE-A-102(RA)



- NOTE:-**
1. WIRING FOR LIGHT, FAN, EXHAUST FAN, 5/15 PLUG POINT ETC. SHALL BE DONE AS PER CPWD TECHNICAL SPECIFICATION.
 2. THE SIZE OF DIFFERENT SWITCH BOARD SHALL BE DECIDED BY TOTAL LOAD CONNECTED AS WELL AS TOTAL NUMBER OF POINTS RESPECTIVELY.
 3. CONCEALED CONDUIT WIRING SHALL BE ADOPTED.
 4. CIRCUIT DIAGRAM & CONDUIT LAYOUT SHALL BE DEVELOPED BY ELECTRICAL CONTRACTOR AND SHALL BE APPROVED BY THE OWNER'S SITE ENGINEER-IN-CHARGE.
 5. MOUNTING HEIGHT OF LUMINARIES AND THEIR ACCESSORIES FROM THE FINISHED FLOOR LEVEL SHALL BE AS PER C.P.W.D. SPECIFICATIONS.
 6. THE LED LIGHT FITTINGS SHALL BE PROVIDED WITH NECESSARY DRIVER.
 7. ANY DOUBT OR MISMATCHING BETWEEN DRAWING AND TECHNICAL SPECIFICATION HAS TO BE BROUGHT TO OWNER'S NOTICE BY THE BIDDER FOR CLARIFICATION BEFORE AWARD OF THE PACKAGE.
 8. THE LOCATION OF METER BOARD, LIGHTING PANEL, SWITCHBOARDS, FIXTURES, FANS ETC., MAY BE MODIFIED BASED ON OWNERS SITE ENGINEER-IN-CHARGE APPROVAL.
 9. SEPARATE CONDUIT SHALL BE LAID FOR TELEPHONE, TV, SUB-MAIN, CIRCUIT, AND POINT WIRING.
 10. WIRING FOR LIGHTING CIRCUIT SHALL BE DONE WITH 2X2.5 SQMM+1X2.5 SQMM FRLS PVC WIRES PER CIRCUIT IN STEEL CONDUIT.
 11. WIRING FOR 5A SOCKET OUTLETS SHALL BE DONE WITH 2X1.5+1X1.5 SQMM FRLS PVC WIRE IN STEEL CONDUIT.
 12. WIRING FOR PRIMARY 15A SOCKET OUTLET SHALL BE DONE WITH 2X4+1X4 SQMM FRLS PVC INSULATED COPPER WIRES AND SECONDARY SOCKET MAY BE CONNECTED WITH 2X2.5+1X2.5 SQMM FRLS PVC COPPER WIRES.
 13. WIRING FOR AC POINTS-20A MODULAR SOCKET OUTLETS SHALL BE DONE WITH 2X4 SQMM+1X4 SQMM FRLS PVC IN STEEL CONDUIT.
 14. INDIVIDUAL ROOMS SHALL HAVE PROVISION OF TELEPHONE & TV. AS SUCH CONDUITING ALONG WITH WIRING SHALL BE ROUTED FROM THE INDIVIDUAL ROOMS UPTO ELECTRICAL ROOMS & TERRACE RESPECTIVELY.
 15. ALL DBS SHOULD BE WITH NECESSARY PROTECTED LIKE OVER CURRENT, SHORT CIRCUIT & EARTH LEAKAGE.
 16. STABILIZER FOR ALL AC UNITS SHALL BE INSTALLED IN BALCONY, HOWEVER AC POINT SOCKET SHALL BE INSTALLED IN THE ROOM W.R.T. DRAWING.




LEGEND

SL No	SYMBOL	DESCRIPTION	HEIGHT(MM)
1		18-20W LED LIGHT FIXTURE - 1200MM (Type: Wipro o LL20-281-XXX-65AL1, Surya SLE BT 20 G1, Bajaj: BCLAB 20WH, Philips)	2300/WALL
2		1X10-12W LED LIGHT FIXTURE-600MM (Type: Philips BN 021 LED125 6500 PSU GR, Wipro o LL20-111-XXX-65AL1or Surya SLE BT 10 IL, Bajaj)	ABOVE MIRROR
3		36-42W WEATHER PROOF LED LIGHT FIXTURE (Type: Bajaj- BIPC 40WLED, Philips WT201C LED44S-6500 PSU L120, Wipro LE23-491-XXX-57-XX, Surya SLE WPL 36W)	
4		36-40W RECESS MOUNTED LIGHT FIXTURE (2x2) (Type: Bajaj/BZRSOL 36W WH or Philips RC380B LED36S-6500 G5 36W WH or Wipro: CRC010R038HP57GL1 or Surya SLE DS 36 22R)	
5		12W LED CEILING MOUNTED LIGHT FIXTURE (Type: Bajaj: BGSLO Sleek Sur face RD 12W WH LED or Surya ATHENA SLE DLS 12W XX RD or Wipro o LD06-151-XXX-40SMG1 or Philips SM250C LED12S- 6500 PSU WH)	CEILING
6		6W LED CEILING MOUNTED LIGHT FIXTURE (Type: Bajaj: BGSLO Sleek Sur face 6W RD, Philips SM250C LED7S, Wipro: LD06-670-XXX-40SMG1, Surya: ATHENA SLE DLR 12W XX RD)	CEILING
7		12W LED RECESS MOUNTED LIGHT FIXTURE (Type: Bajaj: BGSLO Sleek Recess RD 12W WH LED, Philips DN296B LED12S-4000 PSU, Wipro: LD06-151-XXX-40-XX or Surya SLE DLR 12W RIVO RD XX, Bajaj)	RECESS
8		6W LED RECESS MOUNTED LIGHT FIXTURE (Type: Philips DN295B LED6S, Wipro: LD06-670-XXX-40-XX, Surya:SLE DLR 6W RIVO RD XX, Bajaj)	RECESS
9		1X7-10W LED WALL MOUNTED LIGHT FIXTURE (Type:Jaquar JNL-CHR- WLRB0480SE2 / Philips /Wipro)	2300
10		6-10W LED BULK LIGHT FIXTURE (Type: Bajaj,BIBWP 10W LED , Philips : WT202W LED6S CW PSU S2 PC , Wipro o LW07-141-XXX-57-G1, Surya :SLE BLH 10W PLUS)	2400
11		100W LED FLOOD LIGHT FIXTURE (Type: Bajaj: GLATT MT 120L WH PO PC SD or Philips BVP192 LED110 CW HO NB FG GR PSU or Wipro o LF20-122-060-57-G2 or Surya SLE FL 100W IP66 LMS NEO)	6000
12		1200 MM SWEEP BEE 5 STAR RATED CEILING FAN WITH BLD MOTOR(MAKE:Havells-Stealth BLD C FCBHSTIBL48-C /Crompton-Silent Pro Enso Smart/Orient Electric-Aerogilet)	CEILING
13		400MM SWEEP WALL MOUNTED FAN WITH DOUBLE PLUG CART (MAKE:Bajaj /Crompton/Khaitan/Orient)	2100
14		EXHAUST FAN (200MM SWEEP) PLASTIC BODY (MAKE:Bajaj /Crompton/Khaitan/Orient)	CUT OUT LEV.
15		EXHAUST FAN (225/230 MM SWEEP) METAL BODY (MAKE:Bajaj /Crompton/Khaitan/Orient)	CUT OUT LEV.
16		SWITCH BOARD WITH SWITCHES(MODULAR TYPE)	1250
17		TWO WAY SWITCH(MODULAR TYPE)	1250
18		5A SOCKET OUTLET WITH SWITCH(MODULAR TYPE)	500
19		5A SOCKET WITH SWITCH(ON EX.S/W)(MODULAR TYPE)	500/900/1250
20		15/20A AC SWITCH(MODULAR TYPE)	500
21		5/15A OR 5/20A SOCKET OUTLET WITH SWITCH(MODULAR TYPE)	550 ROOMS/1150 ABOVE COUNTER, KITCHEN/1800 OFFICE /1200 REPAIRING MACHINE/1800 AC
22		15L PLASTIC BODY WATER GEYSER (5 STAR RATED)	2100
23		TELEPHONE SOCKET(MODULAR TYPE)	500
24		T.V. SOCKET(MODULAR TYPE)	900
25		BELL PUSH(MODULAR TYPE)	1250
26		CALL BELL(DING-DONG TYPE)	2100
27		MAIN DISTRIBUTION BOARD	WALL MOUNTED
28		METER DISTRIBUTION BOARD	WALL MOUNTED
29		LIGHTING PANEL	1500
30		TELEPHONE DB	1500


		एन टी सी लिमिटेड NTPC Limited (A Govt. of India Enterprise)	
i j; ktuk		GNI GAS ENGINE POWER PROJECT PHASE-I	
PROJECT		108 MW	
TITLE		BACHELOR & SUITE ACCOMMODATION PRE ENGINEERED STRUCTURE FIRST FLOOR ELECTRICAL LAYOUT PLAN	
SIZE	SCALE	DRG. NO.	REV. NO.
A1	NTS	6401-500-TOE-A-102	RA

PART-B
VOLUME – V
MASTER DRAWING LIST

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
1.00.00	Master Drawing List (MDL) This part describes tentative Master Drawing List (MDL). The submission schedules of drawings shall be finalized based on project schedule.			
2.00.00	Engineering Drawing Review Methodology: To reduce engineering cycle time and no. of drawings in approval category, following Engineering Drawing Review Methodology shall be adopted: a. Auto-archive of drawings: Contractor will certify that these drawings are complying with technical specification requirements. Endorsement of drawings: NTPC will select base for endorsement of drawings and submit list of drawings to Contractor for endorsement. The list shall be finalized after discussion with Contractor. After agreement, the approved drawings shall be taken out from DREAMS for endorsement and stamped applicable for Andaman Gas Power Project.. b. Dedicated Contractor and NTPC engineering team shall be identified. c. Wherever input data is not available for preparation of drawing, latest similar projects input data (with not to exceed data) will be used for further engineering. d. Cluster of drawings: The drawings will be identified in different clusters for submission/approval purpose depending upon the requirement at site. The submission schedule shall be decided based on proposed L2 network. The L2 network will be agreed upon with Contractor before NOA. e. After Rev 0 comments, the drawing will be locked in the system. Contractor will review the Rev 0 comments within 7 days & furnish the Comment Reply Sheet (CRS) to NTPC as an agenda point for TCM. TCM shall be conducted with Contractor on non-agreed comments of CRS. f. System will not allow Contractor to submit approval category drawings before the scheduled submission date. However, documents may be unlocked on case-to-case basis. g. Based on resolution of all comments and agreements, the document will be approved in TCM itself. The contractor will revise the document based on the resolutions and certify that all the resolutions has been taken care of. h. Based on this certification, the document will be opened and submitted by contractor in the system for approval as Rev 01 within 10 days of TCM.			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO: CS-6401-001-2	VOLUME V MDL	PAGE 1 OF 4

CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.00.00	GENERAL REQUIREMENTS			
3.00.01	This part describes the technical information and data to be furnished by the Bidder for the equipment and services described in Section-VI.			
3.00.02	The Bidder shall ensure that all information, data, performance curves, technical literature (catalogues) and drawings furnished fully describe all equipment/systems covered and fully meet the requirements of the technical specifications.			
3.00.03	The Employer reserves the right to ask for further details regarding technical features, application particulars, performance, past experience for similar applications or any other information as may be required to fully satisfy himself regarding suitability, quality, reliability and full compliance with this specification for all equipment and systems offered by the Bidder.			
3.00.04	Bidder shall be required to furnish all additional data about the equipment/system being supplied, even if such details are not specified in this section.			
4.00.00	Data Requirements			
4.01.00	Data to be necessarily included in General Arrangement Drawing of respective equipments: <ul style="list-style-type: none">1. Design and Test code2. Make/Manufacturer3. Model/Type4. Equipment Rating/ Basic design data5. Equipment quantity6. Thermal/Mechanical/operational/Performance data as applicable7. Construction data8. Part Lists9. MOC10. Bill of materials (BOM)11. Different dimensions12. Vibration and Sound data13. Nozzle schedule/Connection list (if applicable)14. Allowable Force and Moments of Nozzle (if applicable)15. Different Loads to be considered for foundation design (if applicable)16. Surface preparation and painting schedule17. Major elevations/levels18. Weight of equipment (Empty/operating/full weight), Max weight for maintenance/Erection, Shipping dimensions (size, weight)19. Special/Standard notes (if any)			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO: CS-6401-001-2	VOLUME V MDL	PAGE 2 OF 4

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
4.02.00	Cross-sectional Drawing Data requirement: <div><div>1. Bill of Materials</div><div>2. Different dimensions</div><div>3. Different Clearances</div><div>4. Model Number (if applicable)</div><div>5. Design and testing code</div><div>6. Special/Standard notes (if any)</div></div>			
4.03.00	P&ID / Scheme/Write-up data requirement: <div><div>1. Design pressure/temperature/flow/Velocit</div><div>2. Operating pressure/temperature/flow/Velocit</div><div>3. Line size/thickness</div><div>4. KKS TAG numbers</div><div>5. MOC</div><div>6. Scope & Terminal Points</div><div>7. Special/Standard notes (if any)</div><div>8. In write-up, description of each equipment shall accompany set point, rated parameters/size (as per applicability), permissive, interlock, protection, any curves for variable set point, calculation for variable set point etc.</div></div>			
4.04.00	Sizing calculation <div><div>1. Design/Sizing criteria/Design Parameters</div><div>2. Codes/Standards</div><div>3. Thermal/Hydraulic/ Mechanical calculation</div><div>4. Special/Standard notes (if any)</div><div>5. Sizing related Heat Balance diagrams</div></div>			
4.05.00	Datasheet <div>All the required information shall be compiled from GAD, Cross-sectional drawing, Scheme, Write-up, Sizing document etc and any specific data for a particular equipment which is necessarily to be furnished shall be incorporated in the datasheet of the equipment.</div>			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO: CS-6401-001-2	VOLUME V MDL	PAGE 3 OF 4

CLAUSE NO.	<div>TECHNICAL REQUIREMENTS</div> <div>  </div>		
	<div>Tentative Master Drawing List</div>		
<div>GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE</div>	<div>TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO: CS-6401-001-2</div>	<div>VOLUME V MDL</div>	<div>PAGE 4 OF 4</div>

Tentative Master Drawing List

S.NO.	DRG_TITLE	SUB-SYSTEM	CAT
1	General Layout of the plant	Engine	A
2	Engine hall General arangement INCLUDING FOUNDATION PLAN, LOADING & FIXING DETAILS of equipments	Engine	A
3	SIZING CALC FOR ROPES, WHEELS, DRUM,BUFFERS, BRAKES & MOTORS- EOT CRANE	Engine	A
4	GA OF OIL PURIFIER (PLOT PLAN)	Engine	A
5	P & ID OF TURBINE OIL PURIFIER	Engine	A
6	DATA SHEET OF TURBINE OIL PURIFIER	Engine	A
7	Type test procedure of oil purifier	Engine	A
8	Type test report of oil purifier	Engine	A
9	GA of Clean Oil tank	Engine	A
10	GA of Dirty oil tank	Engine	A
11	P&ID FOR CENTRAL LUBE OIL STORAGE SYSTEM	Engine	A
12	Genset data sheet	Engine	A
13	Engine lube oil coolers data sheet	Engine	A
14	Engine cooling water flow P&ID	Engine	A
15	Engine Lube oil P&ID	Engine	A
16	GA of Radiator	Engine	A
17	DATA SHEET & GA OF LUBE OIL TRANSFER PUMPS	Engine	A
18	DATA SHEET & GA OF LUBE OIL Unloading PUMPS	Engine	A
19	DATA SHEET & GA OF LUBE OIL Engine evacuation PUMPS	Engine	A
20	Engine foundation design drawing	Engine	A
21	OIL COOLER - THERMAL CLACULATION	Engine	A
22	GA & Datasheet- Oil Cooler	Engine	A
23	GA & Datasheet of Oil filter/strainer	Engine	A
24	Engine operating philosophy	Engine	A
25	GA of EOT crane	Engine	A
26	CRAB ASSEMBLY WITH CT WHEEL ASSEMBLY- Engine HALL CRANE	Engine	A
27	HOOK, NUT AND HOOK BLOCK ASSEMBLY OF Main hoist OF Engine HALL EOT CRANE	Engine	A
28	GANTRY RAIL FIXING ARRANGEMENT- EOT CRANE	Engine	A

29	CRANE CLEARANCE DIAGRAM FOR BFP EOT CRANE	Engine	A
30	Engine fuel filtration system scheme and writeup	Engine	A
31	P&ID of air intake system & gas Exhaust system	Engine	A
32	P&ID of Starting air system	Engine	A
33	Master Layout plan of engine hall	Engine	A
34	Fuel gas system - P&ID	Engine	A
35	GA and datasheet of 15 Ton hydraulic crane	Engine	A
36	Start up curve	Engine	A
37	Correction Curve	Engine	A
38	Composite piping layout of Cooling water system	Engine	A
39	Composite piping layout of Lube oil system	Engine	A
40	Composite piping layout of start up air system	Engine	A
41	Sizing of Lube oil coolers	Engine	A
42	Sizing of Radiators	Engine	A
43	Plant Operation philosophy	Engine	A
44	O&M Manual - Engine		
45	PG Test Procedure - Engine		
46	PLC Documentation - Detailed Configuration/ Architecture, BOM, Panel Drawings, data sheets.	C&I	A
47	GA/IA, Schematic and wiring diagram of PLC Based Control System along with Control desk	C&I	A
48	Data Sheet and sizing calculation for Battery for PLC system	C&I	A
49	G.A. & Schematic Drawing of UPS for PLC & Remote I/O Panel	C&I	A
50	FAT (Factory Acceptance Test) Procedure of PLC System	C&I	A
51	I/O List of PLC	C&I	A
52	I/O ASSIGNMENT of PLC system	C&I	A
53	Control Logic Diagram of PLC & Remote I/O Panel along with Graphics and HMI mimics	C&I	A
54	Type Test Report for PLC System	C&I	A
55	Control writeup for PLC based control system	C&I	A
56	Datasheet and BOM for Master Slave Clock System	C&I	A
57	GA DRAWING/DATASHEET/BOM & TYPE TEST REPORT OF PA SYSTEM and DEVICES and ACCESSORIES	C&I	A
58	System configuration , GA/IA, BOM and DATA SHEET FOR CCTV	C&I	A

59	Cable List and cable schedule	C&I	A
60	DATA SHEET FOR HMIPIS system like Servers, Workstations, Printer, Switches, mini UPS etc.	C&I	A
61	DATASHEET FOR INSTRUMENTATION CABLES	C&I	A
62	DATASHEET FOR POWER and SUPPLY CABLES	C&I	A
63	DATASHEET FOR CONTROL CABLES	C&I	A
64	DATA SHEET FOR FIBRE OPTIC CABLE	C&I	A
65	DATA SHEET / BOM / GA / SCHEMATIC / SAMPLING DRG & TYPE TEST REPORT FOR CEMS Analysers	C&I	A
66	DATA SHEET/ BOM / GA / SCHEMATIC / SAMPLING DRG FOR O2 ANALYZER LT	C&I	A
67	DATASHEET AND BOM FOR FURNITURE-CHAIR/PRINTER DESK/COMPUTER TABLE/CONFERENCE TABLE/KEYPAD/LOCKER etc.	C&I	A
68	DATASHEET FOR PRESSURE /DP TRANSMITTER	C&I	A
69	DATASHEET/DRAWING FOR GAS FLOW METERING SYSTEM	C&I	A
70	DATASHEET FOR JUNCTION BOXES	C&I	A
71	DATASHEET/BOM for Impulse Pipe	C&I	A
72	DATASHEET/BOM FOR FITTINGS	C&I	A
73	DATA SHEET/BOM FOR ANALYSERS OF AAQMS	C&I	A
74	GA/LAYOUT/WIRING DRAWING FOR AAQMS	C&I	A
75	Factory Acceptance Test (FAT) report	C&I	A
76	GA. Datasheet, Terminal Box arrangement and Curves of LT motors (for each type and rating)	Electrical	A
77	GA AND LIST OF FITTINGS,R&D plate, HV/LV termination details, bushings GA of oil filled trf- for each rating of oil filled transformer	Electrical	A
78	GA & SLD FOR 33 kV SWITCHGEAR	Electrical	A
79	GA & SLD FOR LT SWITCHGEAR (each type and rating)	Electrical	A
80	Electrical Equipment drawings & Datasheet of HVAC System	Electrical	A
81	Electrical Equipment drawings & datasheet of Air compressor	Electrical	A
82	GA. Datasheet & Wiring diagram of Electric Actuator for Dampers	Electrical	A
83	DG SET CONTROL PANEL- GA & SCHEME	Electrical	A
84	Electrical cum Control Building Equipment Layout with transformer layout	Electrical	A
85	Detail Cable Routing Plan for complete plant	Electrical	A
86	Lightning Protection Layout for complete plant	Electrical	A
87	Cable tray layout - Electrical cum Control Building with transformer yard	Electrical	A

88	service swgr- Control Room - Equipment Layout	Electrical	A
89	Earthing & lightning protection layout- service swgr Room	Electrical	A
90	Cable tray layout-of complete plant	Electrical	A
91	Overall Below grid Earthing Layout for complete plant	Electrical	A
92	Electrical Key Single line diagram	Electrical	A
93	Control Scheme for each type of LT Swgr module	Electrical	A
94	Foundation & Loading gauge, Roller& GA & SCHEMATIC DIAGRAM FOR M. BOX oil filled trf-for each rating of oil filled transformer	Electrical	A
95	SCHEMATIC DIAGRAM 33 kV HV SWGR	Electrical	A
96	DETAILS OF LIGHTNING PROTECTION & EARTHING- CHIMNEY	Electrical	A
97	DATASHEET, GA & SLD FOR 415V SWITCHGEAR	Electrical	A
98	HT & LT TRANSFORMER SIZING CALCULATION	Electrical	A
99	110V/220V DC Battery & battery Charger Sizing Calculation	Electrical	A
100	DG Set Sizing Calculation	Electrical	A
101	Design Guildelines for Cabling including fixing arrangement of flexible cable tray support system	Electrical	A
102	DESIGN GUIDELINES FOR EARTHING & LIGHTNING PROTECTION	Electrical	A
103	Design Guidelines for Lighting System	Electrical	A
104	TYPE TEST REPORT -LT SWITCHGEAR	Electrical	A
105	Type test report for LT motors (each type and rating)	Electrical	A
106	Type test Procedure for LT motors (each type and rating)	Electrical	A
107	BATTERY CHARGER (FLOAT CUM BOOST CHARGER)- TYPE TEST REPORTS.	Electrical	A
108	TYPE TEST REPORTS-- oil filled trf-for each rating of oil filled transformer	Electrical	A
109	Type test procedure for Oil Filled Transformer-each type and rating	Electrical	A
110	BATTERY - TYPE TEST REPORTS	Electrical	A
111	TYPE TEST REPORT FOR 33 KV SWITCHGEAR INCLUDING NUMERICAL RELAYS	Electrical	A
112	DG SETS - TYPE TEST REPORTS	Electrical	A
113	Type Test Report for HT cable	Electrical	A
114	TYPE TEST REPORTS - Dry type transformer	Electrical	A
115	Type test Procedure for motor (each type and rating)	Electrical	A
116	TYPE TEST REPORTS FOR LIGHTING PANELS and DB's	Electrical	A
117	Type Test Report of NSPBD	Electrical	A
118	TYPE TEST REPORT OF JUNCTION BOX - (All type)	Electrical	A
119	FAT PROCEDURE OF RELAY-LT SWITCHGEAR	Electrical	A

120	Type test Report - VFD panel for Mill Circuit Recycle Pump Motor	Electrical	A
121	HT CABLE JOINTING & TERMINATIONS KIT- TYPE TESTS REPORT	Electrical	A
122	DATASHEET AND GA FOR NSPBD	Electrical	A
123	TECHNICAL DATA REQUIREMENT SHEET- oil filled trf-for each rating of oil filled transformer	Electrical	A
124	DATA SHEETS FOR DG SET COMPLETE WITH ALL ACCESSORIES	Electrical	A
125	Datasheet and Cross Section Drawings for HT Power Cables	Electrical	A
126	RELAY CONFIGURATION & SETTINGS FOR HT SWITCHGEAR	Electrical	A
127	DATASHEET FOR 33 KV SWITCHGEAR INCLUDING NUMERICAL RELAYS	Electrical	A
128	Datasheet for Earthing & Lightning Materials	Electrical	A
129	GA,SLD and BOQ of DCFB	Electrical	A
130	Drawing for Power Distribution Panels	Electrical	A
131	GA,SLD and BOQ of ACFB	Electrical	A
132	Control Scheme for each type of HT Swgr module	Electrical	A
133	Type Test Reports for Bus Duct	Electrical	A
134	Type Test Reports for Local Starters	Electrical	A
135	GA and Wiring Local Control Panel (each type and rating)	Electrical	A
136	electrical Load list	Electrical	A
137	Drawing Local Push Button Station.	Electrical	A
138	STANDARD DRAWING FOR DUCT FABRICATION & SUPPORTING ARRANGEMENT	Air Conditioning	AA
139	GA OF AIR TERMINALS LIKE SUPPLY / RETURN AIR DIFFUSER / GRILL,ETC.	Air Conditioning	AA
140	PAC ROOM LAYOUT & AC DUCT LAYOUT FOR MAIN CONTROL ROOM	Air Conditioning	A
141	SPLIT AC SCHEDULE	Air Conditioning	AA
142	P & I DIAGRAM FOR A/C SYSTEM FOR MAIN CONTROL ROOM	Air Conditioning	A
143	DESIGN PHILOSOPY, HEAT LOAD CALCULATION FOR A/C SYSTEMFOR MAIN CONTROL ROOM	Air Conditioning	A
144	TECHNICAL DATA SHEET OF PACKAGED AIR CONDITIONERS	Air Conditioning	A
145	TECHNICAL DATA SHEET & G/A/ DRAWING FOR HEATER PACKAGE	Air Conditioning	AA
146	TECHNICAL DATA SHEET & G/A/ DRAWING OF PAN HUMIDIFIER	Air Conditioning	AA
147	TECHNICAL DATA SHEET & G/A/ DRAWING OF FRESH AIR FAN	Air Conditioning	AA
148	TECHNICAL DATA SHEET FOR HI-WALL & CASSETTE TYPE SPLIT AIR CONDITIONER	Air Conditioning	AA

149	TECHNICAL DATA SHEET FOR THERMAL & ACCOUSTIC INSULATION FOR DUCTING/PIPES	Air Conditioning	AA
150	TECHNICAL DATA SHEET & G/A/ DRAWING OF PRE-FILTER AND FINE FILTER	Air Conditioning	AA
151	TECHNICAL DATA SHEET & G/A/ DRAWING OF FIRE DAMPER WITH ACTUATOR	Air Conditioning	AA
152	DESIGN PHILOSOPHY, HEAT LOAD CALCULATION AND VENTILATION FAN SCHEDULE	Ventilation	A
153	TECHNICAL DATA SHEET & GA DRAWING FOR ROOF EXTRACTOR ALONGWITH FIXING DETAILS	Ventilation	A
154	TECHNICAL DATA SHEET & GA DRAWING FOR AXIAL FANS ALONGWITH FIXING DETAILS	Ventilation	AA
155	P & I DIAGRAM OF COMPRESSED AIR SYSTEM	Compressed air	A
156	P&I DIAGRAM FOR AIR COMPRESSOR & AIR DRYERS	Compressed air	AA
157	DESIGN PHILOSOPHY FOR COMPRESSED AIR SYSTEM ALONG WITH SIZING CALCULATION FOR COMPRESSOR	Compressed air	A
158	PG TEST PROCEDURE OF COMPRESSED AIR SYSTEM	Compressed air	A
159	O&M MANUAL-COMPRESSED AIR SYSTEM	Compressed air	AA
160	TDS & GA OF AIR COMPRESSOR, AIR DRYER & AIR RECEIVERS	Compressed air	A
161	TDS & GA OF VALVES FOR COMPRESSED AIR SYSTEM.	Compressed air	AA
162	ENGINE DOCUMENTS FOR ENGINE DRIVEN FIRE WATER PUMPS [GAD, DATASHEET,FUEL TANK DRAWING]	FDPS	A
163	GA OF FIRE WATER STORAGE TANK ALONGWITH NOZZLE ORIENTATION	FDPS	A
164	FABRICATION DETAILS FOR SHELL, BOTTOM AND ROOF PLATES ALONGWITH ROOF STRUCTURE AND STAIRCASE DETAILS OF FIRE WATER STORAGE TANKS	FDPS	AA
165	G.A. OF DELUGE VALVE HOUSING, CENTRAL HOSE STATION & VALVE CHAMBER	FDPS	AA
166	FDA LAYOUT FOR CONTROL ROOM, MCC, ETC.	FDPS	A
167	FDA & LHS CABLE LAYOUT FOR CABLE GALLERIES	FDPS	AA
168	DESIGN PHILOSOPHY AND WRITE-UP FOR INERT GAS SYSTEM	FDPS	A
169	EXTINGUISHER SCHEDULE	FDPS	AA
170	P&ID OF FIRE WATER PUMPING SYSTEM	FDPS	AA
171	P&ID OF HVWS & MVWS	FDPS	A

172	LAYOUT OF HYDRANT AND SPRAY SYSTEM FOR ENTIRE PLANT	FDPS	A
173	LAYOUT OF HVWS SYSTEM & HYDRAULIC CALCULATION	FDPS	A
174	LAYOUT OF INTERNAL HYDRANT FOR ALL BUILDINGS	FDPS	A
175	LAYOUT OF MVW SPRAY SYSTEM & HYDRAULIC CALCULATION	FDPS	A
176	BLOCK DIAGRAM AND PRESSURE DROP CALCULATION OF HYDRANT & SPRAY SYSTEM	FDPS	A
177	DESIGN CALCULATION FOR FIRE WATER STORAGE TANKS	FDPS	AA
178	DESIGN CALCULATION OF INERT GAS EXTINGUISHING SYSTEM FOR CONTROL ROOM	FDPS	A
179	DATASHEET AND GA DRG OF BASKET TYPE STRAINER	FDPS	AA
180	DATA SHEET - VALVES (GATE VALVE, BFV & CHECK VALVE)	FDPS	AA
181	GA & DATASHEET FOR MOTORISED GATE VALVE.	FDPS	AA
182	DATASHEET AND GA DRG OF HYDRANT VALVES, BRANCH PIPES AND NOZZLE AND 4-WAY VALVES, WATER MONITOR & MULTIPURPOSE NOZZLE	FDPS	AA
183	DATASHEET AND GA DRG OF FIRE HOSE (15 METER AND 7.5 METER) AND COUPLING	FDPS	AA
184	DATASHEET AND GA DRG OF HOSE BOX	FDPS	AA
185	GA & DATASHEET FOR DELUGE VALVE WITH TRIMS	FDPS	A
186	DATASHEET AND GA DRG OF Y-TYPE STRAINER	FDPS	AA
187	GA & DATASHEET FOR H.V.W.SPRAY NOZZLES, M.V.W.SPRAY NOZZLES & QUARTZOID BULB DETECTORS	FDPS	AA
188	DATA SHEET - PIPES & FITTINGS	FDPS	AA
189	TECHNICAL DATA SHEET OF FIRE EXTINGUISHERS	FDPS	AA
190	DATA SHEET & G.A. OF PRESSURE RELIEF DAMPER FOR INERT GAS PROTECTED AREAS	FDPS	AA
191	DATA SHEETS OF INERT GAS COMPONENTS (INDIGENOUS)	FDPS	A
192	DATA SHEETS OF INERT GAS COMPONENTS (IMPORTED)	FDPS	A
193	DATA SHEETS OF FIRE TENDERS & FIRE STATION EQUIPMENTS	FDPS	A
194	GA & WIRING DIAGRAMS OF FIRE PROTECTION SYSTEM (FPS) PLC	FDPS	A
195	DATA SHEET, BOQ & GA OF FIRE ALARM PANEL & REPEATER PANEL	FDPS	A
196	G.A. & WIRING DIAGRAM FOR DELUGE VALVE CONTROL PANEL	FDPS	A
197	DATA SHEET, G.A. & SCHEMATIC DRAWING OF BATTERY CHARGER & BATTERY FOR FPS PLC	FDPS	A

198	PANEL DOCUMENTS FOR ENGINE DRIVEN FIRE WATER PUMPS [DATASHEET, GAD]	FDPS	A
199	I/O LIST OF PLC SYSTEM	FDPS	A
200	INSTRUMENT SCHEDULE	FDPS	AA
201	SCHEMATIC DIAGRAM FOR FIRE DETECTION AND ALARM SYSTEM INCLUDING AREA DISTRIBUTION DETAILS	FDPS	A
202	FIRE ALARM PANEL NETWORKING DIAGRAM	FDPS	A
203	24V DC POWER DISTRIBUTION DIAGRAM FOR FPS PLC PANEL	FDPS	AA
204	FPS PLC - LOGIC DIAGRAMS	FDPS	A
205	FAT PROCEDURE OF FPS PLC	FDPS	AA
206	WRITE-UP AND CONFIGURATION DIAGRAM OF FPS PLC PANEL	FDPS	A
207	TYPE TEST REPORT OF LOOP CABLE	FDPS	AA
208	TYPE TEST REPORT FOR BATTERY & BATTERY CHARGER OF FPS PLC PANEL	FDPS	A
209	TYPE TEST REPORT OF FPS PLC	FDPS	AA
210	FPS PLC GRAPHICS & MIMICS	FDPS	AA
211	DATA SHEET AND GA DRAWING OF SIREN	FDPS	A
212	DATA SHEET & GA OF BATTERY FOR FIRE ALARM SYSTEM (WITH BATTERY SIZING CALCULATIONS)	FDPS	A
213	DATA SHEET OF DIGITAL LHS CABLE	FDPS	A
214	DATA SHEET OF DETECTORS / DEVICES	FDPS	A
215	GA & DATA SHEET FOR SOLENOID VALVE	FDPS	A
216	DATA SHEETS & BOQ OF FPS PLC ITEMS	FDPS	A
217	DATA SHEET OF FRLS CONTROL CABLE	FDPS	A
218	DATA SHEET OF OPTICAL FIBRE CABLE	FDPS	A
219	DATA SHEET - SHORT TERM FIRE SURVIVAL CABLE	FDPS	A
220	DATA SHEETS OF FIELD INSTRUMENTS	FDPS	A
221	DATA SHEET - ULTRASONIC LEVEL TRANSMITTER (FOR FIRE WATER STORAGE TANK)	FDPS	A
222	DATA SHEET - DIFFERENTIAL PRESSURE GAUGE & DIFFERENTIAL PRESSURE SWITCH	FDPS	A
223	DATA SHEETS FDA SYSTEM WORK STATION & PRINTER	FDPS	A
224	POWER SUPPLY CALCULATION OF FPS PLC & PANEL	FDPS	AA

225	OPERATION & MAINTENANCE MANUAL FOR FIRE DETECTION & PROTECTION SYSTEM	FDPS	A
226	Equipment Layout INCLUDING FOUNDATION PLAN, LOADING & FIXING DETAILS in Fire water pump house	FDPS	A
227	MQP Axial fan	QA	E
228	MQP Balancing Valves	QA	A
229	MQP Butterfly Valves	QA	A
230	MQP Centrifugal fan	QA	E
231	MQP Conventional Gate/Globe Valve/ Check Valve (Size >600 NB or Rating Pr Class > 300	QA	E
232	MQP Horizonatal Centrifugal Pumps	QA	E
233	MQP MS ERW Pipe (Black/GI)	QA	E
234	MQP Pipe-CS/SS seamless	QA	A
235	FQP - RECIEPT & STORAGE	QA	E
236	FQP - ERECTION	QA	E
237	MQP Axial/RE fan	QA	E
238	MQP Butterfly Valves	QA	A
239	MQP Centrifugal fan	QA	E
240	MQP Conventional Gate/Globe Valve/ Check Valve (Size >600 NB or Rating Pr Class > 300	QA	E
241	MQP Horizonatal Centrifugal Pumps	QA	E
242	MQP MS ERW Pipe (Black/GI)	QA	E
243	FQP - RECIEPT & STORAGE	QA	E
244	FQP - ERECTION	QA	E
245	MQP Air Dryer	QA	A
246	MQP Air receiver(≥10 bar pressure)	QA	A
247	MQP Ball valve/Plug valve	QA	E
248	MQP Conventional Gate/Globe Valve/ Check Valve (Size >600 NB or Rating Pr Class > 300	QA	E
249	MQP MS ERW Pipe (Black/GI)	QA	E
250	MQP Pipe-CS/SS seamless	QA	A
251	MQP Electric Hoist/EOT Crane/Chain pulley block (> 10 Ton)	QA	A
252	MQP Air Compressor	QA	A
253	MQP PIPE-CS/SS seamless	QA	A

254	FQP - RECEIPT, STORAGE AND ERECTION	QA	A
255	MQP Butterfly Valves	QA	A
256	MQP Conventional Gate/Globe Valve/ Check Valve (Size >600 NB or Rating Pr Class > 300)	QA	E
257	MQP MS ERW Pipe (Black/GI)	QA	E
258	MQP Pipe-CS/SS seamless	QA	A
259	MQP Dual Plate check valve	QA	A
260	MQP Submersible/Sump Pump	QA	A
261	MQP Wrapping & coating materials	QA	A
262	MQP Pipes & Fittings-CI and DI	QA	A
263	FQP - RECEIPT AND STORAGE	QA	E
264	FQP - ERECTION	QA	E
265	MQP-Gas Engine	QA	A
266	MQP for Alternator/Generator and Aux.	QA	A
267	MQP for Excitation System	QA	A
268	MQP for DG Set	QA	A
269	MQP for Cathodic Protection	QA	A
270	Quality plan for passenger cum goods elevator	QA	A
271	VFD PANELS	QA	A
272	MQP for HT Motors	QA	A
273	FIELD QUALITY PLAN FOR HV BUS DUCT (15.75 KV/ 21 KV)	QA	A
274	MQP for Isolated Phase Busduct & Accessories	QA	A
275	MQP for Segregated Phase Busduct & Accessories	QA	A
276	MQP FOR SWITCHGEAR PANEL (11KV & 3.3KV)	QA	A
277	MQP FOR DATA CONCENTRATOR PANEL & INTEGRATION	QA	A
278	MQP FOR Protection Panel (GRP/STRP)	QA	A
279	FAT of Numerical Relay	QA	A
280	MQP for Bus Transfer Panel	QA	A
281	MQP FOR LT SWITCHGEAR	QA	A
282	MQP FOR LT BUSDUCT	QA	A
283	BATTERY CHARGER - 220V	QA	A
284	220V BATTERY BANK - MQP	QA	A
285	MQP OF POLES	QA	A
286	QUALITY PLAN FOR CABLE TRAY SUPPORT STRUCTURE	QA	A

287	MQP-HT Cable	QA	A
288	QUALITY PLAN -LT XLPE Power Cable	QA	A
289	QUALITY PLAN-LT HRPVC Control Cable	QA	A
290	QUALITY PLAN for Cable Tray	QA	A
291	QUALITY PLAN - CABLE JOINTING & TERMINATIONS KIT	QA	A
292	QUALITY PLAN-LT FS POWER Cable	QA	A
293	FIELD QUALITY PLAN FOR CABLE FIRE SEALING SYSTEM TYPE],EPC ELECTRICAL EQUIPMENTS PACKAGE"	QA	A
294	QUALITY PLAN FOR AUX. SERVICE TRANSFORMERS	QA	A
295	MQP FOR LUMINARIES	QA	A
296	MQP FOR LDBS	QA	A
297	MQP FOR AUX. TRANSFORMERS	QA	A
298	Manufacturing quality plan for High Mast	QA	A
299	Manufacturing quality plan for Lighting Transformers	QA	A
300	Generator Transformer - MANUFACTURING QUALITY PLAN	QA	A
301	MANUFACTURING QUALITY PLAN---Shunt Reactor	QA	A
302	Quality Plan of Current Transformer	QA	A
303	Quality Plan of Capacitor Voltage transformer	QA	A
304	MQP FOR SURGE ARRESTER	QA	A
305	MQP FOR BUS POST INSULATOR	QA	A
306	MQP FOR CLAMPS AND CONNECTORS	QA	A
307	MQP FOR IPS AL TUBE	QA	A
308	MQP FOR DISC AND PIN INSULATOR	QA	A
309	MQP FOR ACSR CONDUCTOR	QA	A
310	MQP FOR ABT ENERGY METER	QA	A
311	MQP FOR CIRCUIT BREAKER	QA	A
312	MQP FOR SAS	QA	A
313	MQP FOR INSULATOR HARDWARES	QA	A
314	MQP for Dry Type Transformer	QA	A
315	MQP for UT	QA	A
316	MQP for UAT	QA	A
317	MQP for NEUTRAL GROUNDING TRANSFORMER	QA	A
318	MQP for Oil Purifying Equipment	QA	A
319	MQP for Composite Monitoring System	QA	A

320	WPS FOR TRF TANK	QA	A
321	WPS FOR BUSDUCT	QA	A
322	FIELD QUALITY PLAN FOR POWER TRANSFORMERS (GT, ST & UAT)	QA	A
323	QP OF 11 & 3.3 KV NGR	QA	A
324	QP-Local Control Panel (Electrical)	QA	A
325	MQP FOR L T MOTOR >50KW	QA	A
326	FQP for Gen. and Aux.	QA	A
327	FQP for Electrical works	QA	A
328	MQP FOR AAQMS	QA	A
329	MQP FOR Battery for UPS/ Battrey Charger	QA	A
330	MQP FOR IP Based CCTV	QA	A
331	MQP FOR Control Desk	QA	A
332	MQP for Control Valve	QA	A
333	MQP FOR Electrical Actuator (With gear box if applicable)	QA	A
334	MQP FOR Fiber optic cable	QA	A
335	MQP FOR Fire Alarm System	QA	A
336	MQP for Continous Emission Monitoring system	QA	A
337	MQP FOR Flame Monitoring System (Scanner)	QA	A
338	MQP FOR Instrument Cable	QA	A
339	MQP FOR LVS	QA	A
340	MQP FOR Master Slave Clock System	QA	A
341	MQP FOR PA System (IP Based)	QA	A
342	MQP FOR PLC System	QA	A
343	MQP FOR Pneumatic Actuator Regulating (Power Cylinder HAD,CAD SADC & Burner Tilt)	QA	A
344	MQP for UPS System	QA	A
345	FQP of material receipt, Storage and erection of C&I Items	QA	A
346	Solar PV(Photovoltaic)_ Energy estimation and shadow analysis document	Solar	A
347	Solar PV(Photovoltaic)_ Layout and Single line Diagram of Solar Plant on Rooftop	Solar	A
348	Solar PV(Photovoltaic)_ Design calculation for module mounting structure	Solar	A
349	Solar PV(Photovoltaic)_ Module Mounting Structure	Solar	A
350	Solar PV(Photovoltaic)_ PG TEST PROCEDURE	Solar	A
351	Solar PV(Photovoltaic)_ SPV Module Datasheet	Solar	I

352	Solar PV(Photovoltaic)_ Inverter GA/GTP/Type Test/Datasheet	Solar	A
353	Solar PV(Photovoltaic)_ DC cables Datasheet	Solar	I
354	Solar PV(Photovoltaic)_ AC Power cables Datasheet	Solar	I
355	Solar PV(Photovoltaic)_ Weather Monitoring Station Datasheet	Solar	I
356	Solar PV(Photovoltaic)_ Isolation Transformer GA/GTP/Type Test/ Datasheet	Solar	A
357	Solar PV(Photovoltaic)_ Lightning Protection System GA	Solar	A
358	Solar PV(Photovoltaic)_ O&M Manual	Solar	I
359	Process & Sizing Calculations for Desalination System (Including PT, DMF, UF, SWRO)	WS	A
360	P&ID for Desalination System (Including PT, DMF, UF, SWRO)	WS	A
361	P&ID for chemical dosing system including passivation & RO Cleaning & Flushing System for Desalination System	WS	A
362	Composite Layout for Water System Facilities such as Sea Water Tanks, Desalination System, Service Water System, ETP System etc.	WS	A
363	Equipment Layout of Desalination Plant, Effluent Treatment System including CMB	WS	A
364	Process Flow and mass balance diagram (Including Water balance)	WS	A
365	Sea Water Intake Piping Layout from Intake Pump House to Sea Water Storage Tank	WS	A
366	Piping Layout for RO Reject from Brine Tank to RO Reject Well & from RO Reject well to Outfall Structure in Sea	WS	A
367	GA Drawings for Various Tanks such as Sea Water Storage, RO Permeate Water, Service Water Potable Water etc.	WS	A
368	GA dwg for SWRO Skid including foundations & All Other Civil Inputs Details	WS	A
369	GA dwgs & Datasheet for all Membranes of Desalination System (Including PT, DMF, UF, SWRO - as applicable)	WS	A
370	Complete Valve Schedule with Material Specifications	WS	A
371	Complete Pipe Schedule with Material Specifications	WS	A
372	Painting Schedule & Specifications	WS	A
373	Data sheet, GA drawing, performance curves & cross sectional drawing for High Pressure Pumps for Desalination System	WS	A
374	Data sheet, GA drawing, performance curves & cross sectional drawing for All other Pumps for Desalination System	WS	A

375	Data sheet, GA drawing, performance curves & cross sectional drawing for other Pumps such as Sea Water Intake, Service Water, Potable Water, Effluent Transfer, Waste Disposal etc.	WS	A
376	Datasheet and GA Drawing for Tube settler Pack	WS	A
377	Operation & Control Philosophy for Various Systems of water system	WS	A
378	Mandatory Spares List for WS Facilities	WS	A
379	PG Test Procedure - Water system	WS	A
380	O&M Manual - Water system	WS	A

A -Approval

AA - Auto Archive

E- Endorsement

PART-B
VOLUME – VI
QA&I

Introduction to the Quality assurance specification

For fulfilment of the relevant clauses (Test and inspection) of the General Conditions of Contract and General Technical Requirements of Contract, the Quality Assurance Specification acts as a part of the Technical Specification and is included in the Contract.

This part of the Technical Specification shall be read in conjunction with other parts of the technical specifications, General Technical Requirements and Erection Conditions of the Contract.

This document specifies the quality requirements, to be detailed in terms of Tests/Checks/Procedures at the times of manufacturing, Testing, Inspection and also during installation of various Equipment / Components at the place of manufacturer and / or on the site.

Various standards referred in this document shall be the latest revisions.

The quality requirements are spelt out in the following ways;

- 1) Through description
- 2) In the form of tables

In either of the above two forms the test /checks / procedures are mentioned against particular item/ equipment/ component/ system etc.

This specification also contains the Indicative vendor list (with disclaimer) mentioned against particular item/ equipment/ component/ system etc.

The quality requirements specified in this document and also the vendor list are only indicative and not exhaustive.


GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW \pm 5 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2	SUB-SECTION- Q-00 INTRODUCTION TO QUALITY ASSURANCE SPECIFICATION	Page 1 of 3
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Disclaimer for Indicative Vendor List

- 1.1 Reasonable efforts have been made to collate the sub-vendors proposed by the various main contractors from time to time against different Projects/Packages and accepted by NTPC for various items. However, in case of error/omission, if any, and represented by the successful bidder this will be addressed during the execution of the contract based on the material evidence available with NTPC / Main Contractor.
- 1.2 The approved sub-vendor list drawn is not based on NTPC driven enlistment process but based on the sub- vendors proposed by various Main Contractors. As such, it is possible that some of the Suppliers/Manufacturers who may be involved in similar work/process may not be appearing in the list as such sub-vendors may not have been proposed by Main Contractors against NTPC Contracts.
- 1.3 In case the successful bidder chooses to propose additional sub-vendors with relevant experience after the award of the contract such sub-vendors will be considered in terms of Clause no: 19.1 of GCC, provided the proposals are received sufficiently in time: 90 days prior to ordering date of a Bought Out Items/Start of Manufacturing so as not to impede the progress of the contract.
- 1.4 Sub-vendors have been grouped under different categories of items. It is possible that an item characterized by certain specific features such as range and type required as per Main Contractor's design requirements may not be in the range of the listed sub-vendor's manufacturing process/capability. As such the main contractor to ascertain the vendor's capability to meet his specific requirements before considering a sub-vendor.

- 1.5 It is to be noted by the bidders that any shortfall in contract performance attributable to the sub-vendor listed will not absolve the contractor from his contractual obligations in any manner.
- 1.6 The approval was granted based on the evaluation of relevant capabilities and facilities possessed by the sub-vendor at the time of evaluation. Also, some of the sub-vendors may not be active. As such, the successful bidder is to carry out his own due diligence before considering the listed sub-vendor for subletting: the current status of the sub-vendor, the continued availability of productive resources including Human Resources.
- 1.7 The list of sub-vendors is periodically revised to include new sub-vendors. Such a revision may also see a deletion of certain sub-vendors who may have been disqualified on grounds of inadequate performance or banned in line with NTPC's banning policy. The then current list will be shared with the successful bidder immediately on award.

GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2	SUB-SECTION- Q-00 INTRODUCTION TO QUALITY ASSURANCE SPECIFICATION	Page 3 of 3
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CLAUSE NO	QUALITY ASSURANCE	
	QA& I REQUIREMENTS OF GAS ENGINES:	
1.00.00	All materials shall be tested as per relevant national/international standard or manufacturer's internal plant standard meeting technical specification requirements.	
2.00.00	Casting and forgings shall be NDT tested as per relevant national/international standard/manufacturer's internal plant standard meeting technical specification requirements.	
3.00.00	Assembly, run test and performance shall be as per manufacturer's plant standard meeting technical specification requirements.	
4.00.00	Gas system/Lube Oil/ cooling water system/Air Intake and Exhaust System/ Insulation & cladding and RLNG forwarding system/governing system(as applicable) shall be tested as per manufacturer's plant standard meeting technical specification requirements.	
5.00.00	All the Engines along with associated auxiliaries shall be tested at the Factory.	
6.00.00	Noise level shall be as per standards of MoEF & CC and Central pollution Control Board (CPCB), India/ technical specification requirements.	
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LOW PRESSURE PIPING/STATION PIPING

PIPES, FITTINGS, BENDS, VALVES, COATING-WRAPPING, STRAINERS EXPANSION, JOINTS, TANKS, FASTENERS, LINING ETC.

	Tests/Check Items / Components	Material Test	DPT/MPI / RT	Ultrasonic Test	WPS/ WQS/PQR	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operation al Test	Other Tests	All Tests as per relevant Std	REMARKS
1	Pipes & Pipe Fittings	Y ^a	Y ^b			Y ¹			Y			Y	
2	Diaphragm Valves	Y ^a				Y ⁵			Y		Y ⁶		
3A	Cast Butterfly Valves (Low Pressure)					Y		Y	Y	Y	Y ⁷		
	Body	Y ^a	Y ^b										
	Disc	Y ^a	Y ^b										
	Shaft	Y ^a	Y	Y ^c									
3B	Fabricated Butterfly Valves	REFER NOTE 14											
4	Gate/ Globe/Swing Check / Ball Valves	Y ^a	Y ^b	Y ^c		Y ⁵	Y	Y	Y	Y	Y ⁸		
5	Dual Plate Check Valves	Y ^a	Y ^b	Y ^c		Y	Y	Y	Y	Y	Y ⁴		
6	Rolled & Welded Pipes and Mitre Bends	Y ^a	Y ³		Y	Y ³			Y		Y ^{3&15}	Y	
7	Coating & Wrapping of Pipes	Y ²									Y ²		
8	Tanks & Vessels	Y ^a	Y ^b		Y	Y			Y		Y ¹⁶		
9	Strainers	Y ^a	Y ^b		Y [#]	Y					Y ¹¹		#For Fabricated Strainer
10	Rubber Expansion Joints	Y ^a				Y ¹²		Y	Y		Y ¹³		
11	Internal Lining of Pipes	Y ^a							Y		Y ⁹		
12	Site Welding		Y ¹⁰		Y	Y							
NOTES (MEANING OF SUPERSSCRIPTS)													
a	One per heat/heat treatment batch/lot.												
b	On machined surfaces only for castings and on butt welds.												
c	For shaft/spindles > or = 40 mm												
1	100% Hydraulic test shall be carried out. Weld joints not subjected to hydraulic test due to some unavoidable reasons, shall be subjected to 100% RT/PAUT.												

CLAUSE NO	QUALITY ASSURANCE	
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2	Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91/ IS-10221 & IS 15337 as applicable.														
3	<p>Followings are the testing requirements for fabrication of pipes at site</p> <table> <tr> <th>TESTS</th><th>QUANTUM OF CHECKS</th></tr> <tr> <td>WPS, PQR, Welder Qualification Test</td><td>100% Welders and WPS shall be qualified as per ASME- section IX</td></tr> <tr> <td>DPT on root run</td><td>100% for pipes up to 1200 mm diameter</td></tr> <tr> <td>DPT after back gauging</td><td>100% for pipes above 1200 mm diameter</td></tr> <tr> <td>RT / UT by (TOFD/PAUT) Technique</td><td>5% (100% of T Joints)</td></tr> <tr> <td>DPT on finished butt weld joints</td><td>10%</td></tr> <tr> <td>Hydraulic Test</td><td>100%, 1.5 times the design pressure or 2 times the working-pressure whichever is higher.</td></tr> </table>	TESTS	QUANTUM OF CHECKS	WPS, PQR, Welder Qualification Test	100% Welders and WPS shall be qualified as per ASME- section IX	DPT on root run	100% for pipes up to 1200 mm diameter	DPT after back gauging	100% for pipes above 1200 mm diameter	RT / UT by (TOFD/PAUT) Technique	5% (100% of T Joints)	DPT on finished butt weld joints	10%	Hydraulic Test	100%, 1.5 times the design pressure or 2 times the working-pressure whichever is higher.
TESTS	QUANTUM OF CHECKS														
WPS, PQR, Welder Qualification Test	100% Welders and WPS shall be qualified as per ASME- section IX														
DPT on root run	100% for pipes up to 1200 mm diameter														
DPT after back gauging	100% for pipes above 1200 mm diameter														
RT / UT by (TOFD/PAUT) Technique	5% (100% of T Joints)														
DPT on finished butt weld joints	10%														
Hydraulic Test	100%, 1.5 times the design pressure or 2 times the working-pressure whichever is higher.														
4	Dry Cycle Test on Dual Plate Check valve spring for one lakh Cycles shall be carried out as a type test. If Dry Cycle test carried out earlier for same material & diameter, Test report shall be reviewed.														
5	Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.														
6	Tests on rubber parts shall be conducted per batch of rubber mix for tensile, Elongation, hardness, adhesion, spark test, bleed resistance test. In addition, type test for 50,000 cycles of each type of diaphragm shall also be conducted.														
7	Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with governing design standard in presence of owner / owner's representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. For Proof of Design Test refer respective chapters of engineering portion in the technical specification.														
8	Blue matching, wear travel for gates, valves, pneumatic seat leakage, and reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes. Fire safe test for ball valve shall be done wherever specified. In case of already carried out, the test report shall be submitted for review and acceptance by owner / owner's representatives. Valves shall be offered for hydro test in unpainted condition.														
9	Tensile, Elongation, Hardness, Specific Gravity, Lining Thickness, Humidity Check, Pipe temperature check, Adhesion Test and Holiday Detection Test etc as per applicable standard shall be done for all lining material and application.														
10	10% of welds (Root and finished welds) shall be subjected to DPT. (100% DPT for compressed air line and boiler & deaerator fill line).														
11	Pressure drop across the strainer for each type and size as a special test shall be carried out. In case of already carried out, the test report shall be submitted for review and acceptance by owner / owner's representatives.														
12	During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.														
13	Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149/IS 3400 Part 20 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.														
14	<p>In addition of all tests as indicated for Cast Butterfly valve being applicable for fabricated butterfly valves, following test shall be done for Fabricated Butterfly Valve:</p> <ol style="list-style-type: none"> UT as per ASTM A-435/IS 11630 & IS 4225 on plate material for body and disc shall be carried out for plate thickness 25mm and above. 100% RT and DPT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc. 10% DPT on other welds shall be done. Post weld heat treatment as per ASME, Section-VIII, Division-I on butt joints of body and disc. Welders and WPS shall be qualified as per ASME- section IX 														

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15	Maximum number of segments in segmental flanges shall be four (04) only. All butt weld joints in the segmental flanges shall be examined by RT/UT. Segmental flanges exceeding 37.5 mm thickness shall be stress relieved as per norms of ASME Section VIII after welding.
16	For pressure vessel welds RT shall be done as per design code requirements.
17	All Valves shall be offered for inspection in unpainted condition
18	No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.

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RAW WATER PIPING

PIPES, FITTINGS, BENDS, VALVES, COATING-WRAPPING, STRAINERS EXPANSION, JOINTS, TANKS, FASTENERS, LINING ETC.

	Tests/Check Items / Components	Material Test	DPT/MPI / RT	Ultrasonic Test	WPS/ WQS/PQR	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operational Test	Other Tests	All Tests as per relevant Std	REMARKS
1	Pipes & Pipe Fittings	Y ^a	Y ^b			Y ¹			Y			Y	
2	Diaphragm Valves	Y ^a				Y ⁵			Y		Y ⁶		
3A	Cast Butterfly Valves (Low Pressure)					Y		Y	Y	Y	Y ⁷		
	Body	Y ^a	Y ^b										
	Disc	Y ^a	Y ^b										
	Shaft	Y ^a	Y	Y ^c									
3B	Fabricated Butterfly Valves	REFER NOTE 14											
4	Gate/ Globe/Swing Check / Ball Valves	Y ^a	Y ^b	Y ^c		Y ⁵	Y	Y	Y	Y	Y ⁸		
5	Dual Plate Check Valves	Y ^a	Y ^b	Y ^c		Y	Y	Y	Y	Y	Y ⁴		
6	Rolled & Welded Pipes and Mitre Bends	Y ^a	Y ³		Y	Y ³			Y		Y ^{3&15}	Y	
7	Coating & Wrapping of Pipes	Y ²									Y ²		
8	Tanks & Vessels	Y ^a	Y ^b		Y	Y			Y		Y ¹⁶		
9	Strainers	Y ^a	Y ^b		Y #	Y					Y ¹¹		#For Fabricated Strainer
10	Rubber Expansion Joints	Y ^a				Y ¹²		Y	Y		Y ¹³		
11	Internal Lining of Pipes	Y ^a							Y		Y ⁹		
12	Site Welding		Y ¹⁰		Y	Y							

NOTES (MEANING OF SUPERSSCRIPTS)

- | | |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| a | One per heat/heat treatment batch/lot. |
| b | On machined surfaces only for castings and on butt welds. |
| c | For shaft/spindles > or = 40 mm |
| 1 | 100% Hydraulic test shall be carried out. Weld joints not subjected to hydraulic test due to some unavoidable reasons, shall be subjected to 100% RT/PAUT. |
| 2 | Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91/ IS-10221 & IS 15337 as applicable. |
| 3 | Followings are the testing requirements for fabrication of pipes at site |

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	TESTS		QUANTUM OF CHECKS		
	WPS, PQR, Welder Qualification Test		100% Welders and WPS shall be qualified as per ASME- section IX		
	DPT on root run		100% for pipes up to 1200 mm diameter		
	DPT after back gauging		100% for pipes above 1200 mm diameter		
	RT / UT by (TOFD/PAUT) Technique		5% (100% of T Joints)		
	DPT on finished butt weld joints		10%		
	Hydraulic Test		100%, 1.5 times the design pressure or 2 times the working-pressure whichever is higher.		
4	Dry Cycle Test on Dual Plate Check valve spring for one lakh Cycles shall be carried out as a type test. If Dry Cycle test carried out earlier for same material & diameter, Test report shall be reviewed.				
5	Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.				
6	Tests on rubber parts shall be conducted per batch of rubber mix for tensile, Elongation, hardness, adhesion, spark test, bleed resistance test. In addition, type test for 50,000 cycles of each type of diaphragm shall also be conducted.				
7	Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with governing design standard in presence of owner / owner's representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. For Proof of Design Test refer respective chapters of engineering portion in the technical specification.				
8	Blue matching, wear travel for gates, valves, pneumatic seat leakage, and reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes. Fire safe test for ball valve shall be done wherever specified. In case of already carried out, the test report shall be submitted for review and acceptance by owner / owner's representatives. Valves shall be offered for hydro test in unpainted condition.				
9	Tensile, Elongation, Hardness, Specific Gravity, Lining Thickness, Humidity Check, Pipe temperature check, Adhesion Test and Holiday Detection Test etc as per applicable standard shall be done for all lining material and application.				
10	10% of welds (Root and finished welds) shall be subjected to DPT. (100% DPT for compressed air line and boiler & deaerator fill line.).				
11	Pressure drop across the strainer for each type and size as a special test shall be carried out. In case of already carried out, the test report shall be submitted for review and acceptance by owner / owner's representatives.				
12	During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.				
13	Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149/IS 3400 Part 20 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.				
14	In addition of all tests as indicated for Cast Butterfly valve being applicable for fabricated butterfly valves, following test shall be done for Fabricated Butterfly Valve: a. UT as per ASTM A-435/IS 11630 & IS 4225 on plate material for body and disc shall be carried out for plate thickness 25mm and above. b. 100% RT and DPT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc. 10% DPT on other welds shall be done. c. Post weld heat treatment as per ASME, Section-VIII, Division-I on butt joints of body and disc. d. Welders and WPS shall be qualified as per ASME- section IX				
15	Maximum number of segments in segmental flanges shall be four (04) only. All butt weld joints in the segmental flanges shall be examined by RT/UT. Segmental flanges exceeding 37.5 mm thickness shall be stress relieved as per norms of ASME Section VIII after welding.				
16	For pressure vessel welds RT shall be done as per design code requirements.				
17	All Valves shall be offered for inspection in unpainted condition.				
18	No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.				
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RAW WATER SYSTEM EQUIPMENT

Tests/Check Items / Components		Material Test	DPT/MPI	Ultrasonic test	RT	Balancing	Hydraulic / Water Fill test	Pneumatic Test	Assembly/ fit up	Dimensions	Functional/operational Test	Performance Test	Other Test	All Test as per relevant Std/ Approved Data Sheets	Remarks
A.	VT PUMPS & CENTRIFUGAL PUMPS (HORIZONTAL / VERTICAL), SUMP PUMPS, SUBMERSIBLE PUMPS, DRAINAGE PUMP								Y ¹	Y		Y ²			
1	Shaft	Y ^a	Y ^b	Y ^c		Y				Y					
2	Impeller	Y ^a	Y ^b		Y ³	Y							Y ^d		
3	Suction Bell / Bowl Castings/ Inserts	Y ^a	Y ^b				Y			Y			Y ⁶		
4	Discharge Head / Column Pipes / Distance Piece/Base Plate	Y ^a	Y ^b	Y ^c	Y ⁴		Y		Y						
5	Companion Flanges	Y ^a	Y ^b	Y ^c	Y ⁵				Y						
5	Thrust Bearing (Tilting Pad type)	Y ^a	Y	Y					Y	Y				Y	
B.	RE JOINTS	Y ^a					Y ¹⁰		Y	Y			Y ¹¹		
C.	CRANES & HOISTS	REFER QA CHECKS ON EOT CRANES AND HOISTS													
E.	VENTILATION FANS									Y		Y		Y	
1)	Hub/Blades/Casing /Impeller	Y	Y			Y									
2)	Shaft	Y ^a	Y	Y ^c											
3)	Pre/Fine Filters												Y ¹⁴		

Notes:

a	One per Heat/ Heat Treatment Batch/ Lot.
b	On machined surfaces only for Castings / Forgings and on Welds of Fabricated Components.
c	For Shaft diameter. ≥ 50 mm and for plate thickness ≥ 25 mm

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d	Inter Grannular Corrosion (IGC) Test shall be carried out on SS Castings.
1	Trial assembly of all Vertical Turbine Pump components with Column Pipes, Discharge Head, and Motor Stool shall be carried at shop.
2	Performance testing of Pumps shall be carried out at shop, as per HIS standard to determine Head & Flow Characteristics.
3	In case of pump impellers, Radiographic Examination shall be conducted as per ASTM E186/446 with Severity Level 2 for Gas porosity, Level 3 for Sand, Slag and Shrinkage. Cracks, Inserts and Mottling are not acceptable. Radiographic Examination should cover Vanes, Vane Junctions, Full Radial depth of Hub & other accessible areas of the rest of the Impeller.
4	Random 10% RT to be conducted on butt welds for Thk ≥ 10 mm & ≤ 25 mm and 100% RT to be conducted on butt welds for Thk > 25 mm (RT may be replaced by Ultrasonic Test due to constraint if any.) Stress relieving shall be carried out as per norms of ASME Section VIII.
5	Segmental Flanges exceeding 37.5 mm thickness shall be stress relieved after welding. All butt weld joints in segmental flange shall be examined by Radiographic Test. (RT may be replaced by Ultrasonic Test due to constraint if any.) Maximum number of segments shall be 4 only.
6	No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.
7	Hydraulic Test of Body, Seat and Disc strength shall be carried out in accordance with latest edition of AWWA C-504. Actuator operated Valves shall be checked for Seat Leakage by closing the Valve with Job Actuator. Seat Leakage test shall be carried out in both directions.
8	For Proof of Design Test refer respective chapters of engineering portion in the technical specification.
9	For Butterfly Valves of Fabricated construction (Sizes 600mm and above), butt Welds of thickness 20mm & above shall be subjected to 100% Radiography and Components shall undergo stress relieving.
10	During Hydraulic & Vacuum test at 30 mm Hg absolute in 3 different positions, the change in Circumference of the Arch should not be more than 1.5%. Permanent Set, after 24 hours of the test, should not exceed 0.5% of Arch.
11	Tests on Rubber for Tensile, Elongation, Hardness, Hydraulic Stability as per ASTM D-471, Ozone Resistance test as per ASTM D-1149, Aging test, Adhesion strength of Rubber to Fabric and Rubber to Metal shall be carried out.
14	Type / Routine tests as per requirements of BS-6540/ ASHRAE-52-76 for Dust arrestance shall be carried out.

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LAYING/ERECTION OF PIPES

(1) Followings are the Quality Assurance Requirements for laying of 3 LPE Coated MS Pipes

A RECEIPT OF ITEMS AT SITE

Check for completeness of supply and visual check for damage of followings after receipt at site:

- i. 3 LPE Coated MS Pipes, fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.
- ii. Welding electrodes, filler rods & wires, gases like oxygen, acetylene, argon, carbon di-oxide, propane etc.
- iii. X-ray & gamma ray equipment, dye penetrants, RT films,
- iv. Epoxy Primer, Paint, Heat Shrinkable Sleeve, Coating and wrapping material

B STORAGE

Check for proper storage of following items as per manufacturer recommendations / storage guideline

- i. 3 LPE Coated MS Pipes, fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.
- ii. Welding electrodes, filler rods & wires, gases like oxygen, acetylene, argon, carbon di-oxide, propane etc.
- iii. X-ray & gamma ray equipment, dye penetrants, RT films.
- iv. Epoxy Primer, Paint, Heat Shrinkable Sleeve, Coating and wrapping material

C Following checks shall be carried out during Laying of 3LPE Pipes

- i. Ensure proper alignment & fit up
- ii. Ensure correct joining of pipes
- iii. Ensure installation of supports (as applicable)
- iv. Hydraulic Test of section and complete pipeline as per Engg technical specification requirements.

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D JOINING OF 3 LPE COATED MS PIPES AT SITE BY WELDING

Following checks shall be carried out during joining of 3 LPE coated MS pipes at site by welding

- i. Dimensional conformity
- ii. Tolerance OD/ Ovality
- iii. Ensure proper alignment of pipes, Edge preparation and joint fit up
- iv. Ensure Tack weld by qualified welder and provision of internal bracing to keep in proper shape
- v. WPS, PQR & WPQ (welder performance qualification) tests prior to welding
- vi. Check for surface defects after welding (visual)
- vii. 100% DPT on root run/ after back gauging/ grinding of butt weld as applicable
- viii. 10% DPT on fillet weld
- ix. 10% DPT on finished butt welds
- x. 5% RT/ 5% UT by TOFD/PAUT techniques on those butt weld joints which can be 100% hydro tested.
- xi. 100% RT / 100% UT by TOFD/PAUT technique of the butt weld joints of pipeline shall be carried out which cannot be Hydro tested.

E WRAPPING & COATING OF HEAT SHRINKABLE SLEEVE, PROCEDURE QUALIFICATION TEST

Following checks shall be carried out during Procedure Qualification Test (PQT) of application (wrapping and coating) of Heat Shrinkable Sleeve as well as during regular work (Wrapping & Coating) of Heat Shrinkable Sleeve after PQT

- i. Before start of work, ensure followings
 - a. Use of correct raw material i.e. epoxy primer, wrap around heat shrinkable sleeve of NTPC acceptable make & grade.

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	<p>b. The applicator agency deployed for the work shall have adequate experience and approved by NTPC.</p> <p>c. All the butt weld joints shall have acceptable NDT (RT/UT & DPT) and Hydraulic test records.</p> <p>ii. Ensure proper cleaning and Surface preparation of butt weld joints & adjoining pipe surface as per approved procedure complying with relevant clauses of Specification.</p> <p>iii. Finished Surface - Visual Examination, Measurement of Surface Roughness, Profile, dust contamination</p> <p>iv. Ensure compliance of correct time interval between blasts cleaned ready pipe & coating.</p> <p>v. Ensure use of correct size of Wrap around heat shrinkable sleeve on each joint</p> <p>vi. Ensure adequate pre – heating of pipe</p> <p>vii. Ensure application of correct epoxy primer (check make, grade, date of manufacturing, date of expiry) immediately after preheating</p> <p>viii. Visual Examination & Wet film thickness measurement after epoxy primer coat</p> <p>ix. Ensure application of wrap around heat shrinkable sleeve entirely around the pipe when the epoxy is still wet.</p> <p>x. Ensure proper heat duration / temperature during application of heat on wrap around heat shrinkable sleeve</p> <p>xi. Finished coat</p> <p>a. Visual examination,</p> <p>b. Measurement of coat thickness (on pipe body and on weld bead),</p> <p>c. Holiday Test</p> <p>d. Peel – off test</p> <p>e. Overlap Test</p>	
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(2) Followings are the Quality Assurance Requirements for laying/erection of MS Pipes

A RECEIPT OF ITEMS AT SITE

Check for completeness of supply and visual check for damage of followings after receipt at site:

- i. MS Pipes, fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.
- ii. Welding electrodes, filler rods & wires, gases like oxygen, acetylene, argon, carbon di-oxide, propane etc.
- iii. X-ray & gamma ray equipment, dye penetrants, RT films, Epoxy Primer, Paint, Coating and wrapping material

B STORAGE

Check for proper storage of following items as per manufacturer recommendations / storage guideline

- i. MS Pipes, fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.
- ii. Welding electrodes, filler rods & wires, gases like oxygen, acetylene, argon, carbon di-oxide, propane etc.
- iii. X-ray & gamma ray equipment, dye penetrants, RT films.
- iv. Epoxy Primer, Paint, Coating and wrapping material

C Following checks shall be carried out during Laying of MS Pipes

- i. Ensure proper alignment & fit up
- ii. Ensure correct joining of pipes
- iii. Ensure installation of supports (as applicable)
- iv. Hydraulic Test of section and complete pipeline as per Engg technical specification requirements.

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D JOINING OF MS PIPES AT SITE BY WELDING

Following checks shall be carried out during joining of MS pipes at site by welding

- i. Dimensional conformity
- ii. Tolerance OD/ Ovality
- iii. Ensure proper alignment of pipes, Edge preparation and joint fit up
- iv. Ensure Tack weld by qualified welder and provision of internal bracing to keep in proper shape
- v. WPS, PQR & WPQ (welder performance qualification) tests prior to welding
- vi. Check for surface defects after welding (visual)
- vii. 100% DPT on root run/ after back gauging/ grinding of butt weld as applicable.
- viii. 10% DPT on fillet weld
- ix. 10% DPT on finished butt welds
- x. 5% RT/ 5% UT by TOFD/PAUT techniques on those butt weld joints which can be 100% hydro tested.
- xi. 100% RT / 100% UT by TOFD/PAUT technique of the butt weld joints of pipeline shall be carried out which cannot be Hydro tested.


E CHECKS ON PAINTING OF OVERGROUND MS PIPES

- i. Before start of work, ensure followings
 - a. Use of correct raw material i.e. primer, paint of NTPC acceptable make & grade.
 - b. All the butt weld joints shall have acceptable NDT (RT/UT & DPT) and Hydraulic test records.
- ii. Ensure proper cleaning and Surface preparation of butt weld joints & complete pipe surface as per approved procedure complying to relevant clauses of Specification.
- iii. Finished Surface - Visual Examination, Measurement of Surface Roughness, Profile, dust contamination


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	<p>iv. Ensure compliance of correct time interval between blast cleaned ready pipe & coating / painting</p> <p>v. Ensure application of correct primer, paint (check make, grade, date of manufacturing, date of expiry)</p> <p>xii. Visual Examination & Wet film thickness measurement after primer coat, paint coats</p> <p>xiii. Finished coat</p> <p>a. Visual examination,</p> <p>b. Measurement of coat thickness (on pipe body and on weld bead),</p> <p>(3) Followings are the Quality Assurance Requirements for laying of DI pipes</p> <p>A RECEIPT OF ITEMS AT SITE</p> <p>Check for completeness of supply and visual check for damage of followings after receipt at site:</p> <p>DI Pipes, DI Pipes fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.</p> <p>B STORAGE</p> <p>Check for proper storage of following items as per manufacturer recommendations / storage manual</p> <p>DI Pipes, DI Pipes fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.</p> <p>C LAYING OF DI PIPES</p> <p>Following checks shall be carried out during Laying of DI Pipes</p> <p>v. Ensure proper alignment & fit up</p> <p>vi. Ensure correct joining of pipes</p> <p>vii. Ensure installation of supports (as applicable)</p> <p>viii. Hydraulic Test of section and complete pipeline as per Engg technical specification requirements.</p>	
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Test/Check Items / Components	Material Test	WPS/PQR/Welder	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic test / Pneumatic test / Vacuum test	Performance Test	Test as per relevant Std / Appd. Data Sheets	Other Tests	Remarks


COMMON ITEMS:											LEGENDS: Applicable tests are identified by 'Y'. Y ^a : One per Heat / Heat Treatment batch / Lot. Y ^b : On machined surfaces only. Also 100% on Butt Welds & 10% on Fillet Welds. Y ^c : UT shall be done for shafts with Dia 40 mm or above & Plates of Thickness 25 mm or above. Y ^d :Dynamic Balancing per IS: 21940, Grade 6.3 minimum shall be conducted for rotating assy. Y ¹ : As per Pump governing standard. Tolerences as per HIS, USA. Y ² : Random 10% RT to be conducted on butt welds for Thk ≥10 mm. Y ³ : Seat Leakage Test for actuator operated valves shall be done by operating the valve with job actuator. Y ⁴ : Tests on Rubber Diaphragms shall be conducted per batch of Rubber mix for Tensile, Elongation, Hardness, Thickness, Bleed Resistance. In addition, Type Test for 50,000 cycles for each type of diaphragm shall also be conducted.
1. Horizontal Centrifugal Pumps				Y	Y			Y ¹	Y		
1.1. Casing	Y ^a		Y ^b		Y		Y				
1.2. Impeller	Y ^a		Y ^b		Y					Y ^d	
1.3. Shaft	Y ^a		Y		Y					Y ^c	
2. Vertical Pumps				Y	Y			Y ¹	Y		
2.1. Casing	Y ^a		Y ^b		Y		Y				
2.2. Impeller	Y ^a		Y ^b		Y					Y ^d	
2.3. Shaft	Y ^a		Y		Y					Y ^c	
2.4. Fabricated Parts	Y ^a	Y	Y ^b		Y	Y ²	Y				
3. Dosing/ Metering Pumps, Acid/Alkali unloading Pumps	Y ^a				Y		Y	Y ¹	Y		
4. Gate/ Globe/ Check Valves	Y ^a		Y ^b		Y		Y	Y	Y	Y ³ , Y ⁶	
5. Dual Plate Check Valves	Y ^a		Y ^b		Y		Y	Y	Y	Y ⁶ , Y ¹²	
6. Diaphragm Valves	Y ^a				Y		Y		Y	Y ⁴ , Y ³	
7. Butterfly Valves (Low Pr.)				Y	Y		Y	Y	Y	Y ³	
7.1 Body & Disc (Cast	Y ^a		Y ^b		Y						
7.2 Body and Disc (Fabricated)	Y ^a	Y	Y ^b		Y				Y	Y ²	
7.3 Shaft	Y ^a		Y ^b		Y					Y ^c	
8. Plug/ Ball Valves (Low Pr.)	Y ^a		Y ^b	Y	Y		Y	Y	Y	Y ³	
9. Blowers/ Compressors	Y ^a		Y ^b	Y	Y			Y	Y	Y ^c , Y ^d	

CLAUSE NO		QUALITY ASSURANCE											
Test/Check	Items / Components	Material Test	WPS/PQR/Welder	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic test / Pneumatic test / Vacuum test	Performance Test	Test as per relevant Std / Appd. Data Sheets	Other Tests	Remarks	

10. Tanks/ Pressure Vessels	Y ^a	Y	Y ^b	Y	Y	Y ⁸	Y		Y	Y ⁷	<p>Y⁶ : Blue Matching, Wear Travel for Gate Valves and reduced pressure test for check valves shall be conducted as per relevant standards.</p> <p>Y⁷ : Heat Treatment of the Tank/Vessel shall be done per fabrication code requirement. Welded dished ends shall be stress relieved. Dished ends manufactured by cold working shall also be stress relieved as per the requirement of code.</p> <p>Y⁸ : RT as per fabrication code requirements. However, dished ends welds, if manufactured by using welded plates shall be subjected to 100% RT.</p> <p>Y⁹ : Rubber Lining Mix shall be subjected to Bleed Resistance Test on mould sample. Adhesion Test, Spark Test and Hardness Test for the Rubber lined jobs shall also be conducted.</p> <p>Y¹⁰ : Gear Boxes shall be checked for smooth No Load Operation at shop to verify noise and vibration levels. Gear Ratio and Kerosene Leak Test shall also be conducted.</p> <p>Y¹¹ : One Fan of each type & size shall be routine performance tested as per corresponding code for air flow, static pressure, total pressure, speed, efficiency, power consumption, noise & temperature rise. Also all Fans</p>		
11. Rubber Lining	Y ^a				Y				Y	Y ⁹			
12. Strainers	Y ^a	Y	Y ^b	Y	Y		Y		Y				
13. Pipe & Pipe Fittings	Y ^a	Y	Y		Y	Y ⁸	Y		Y				
14. Agitators /Flash Mixer/ Flocculator	Y ^a	Y	Y ^b	Y	Y			Y		Y ¹⁰			
15. Ventilation/Exhaust Fan	Y ^a		Y ^b	Y	Y			Y ¹ ₁	Y	Y ^{c, Y^d}			
16. Hoists & Cranes	Y ^a	Y	Y ^b	Y	Y	Y ⁸		Y	Y				
17. Wrapping & Coating Material	Y				Y				Y				
18. Package/ Split AC	Y							Y	Y	Y ¹⁴			
PT & LET PLANT:													
1. Clariflocculator / Reactor Clarifier / Plate or Tube Settler	Y ^a	Y	Y ^b	Y	Y				Y	Y ¹⁰			
2. Pressure / Vacuum Relief valve / Pressure Regulating Valve	Y ^a			Y	Y		Y	Y	Y				

CLAUSE NO		QUALITY ASSURANCE											
Test/Check	Items / Components	Material Test	WPS/PQR/Welder	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic test / Pneumatic test / Vacuum test	Performance Test	Test as per relevant Std / Appd. Data Sheets	Other Tests	Remarks	


DM PLANT												<p>shall be subjected to run test of 4 hours during which noise, vibration, temperature rise and current drawn shall be measured.</p> <p>Y¹² :Dry cycle test on valve spring for 1, 00,000 cycles shall be carried out as type test, if not carried out earlier, for the similar MOC, size and type of spring.</p> <p>Y¹³ :Test as per approved supplier practice.</p> <p>Y¹⁴ : Electronic leak test for condenser & evaporator unit.</p> <p>Note:</p> <p>1.The complete Piping system along with valves & fittings shall be hydraulically tested at 1.5 times design pressure or 2 times working pressure whichever is higher after erection at site.</p> <p>2. In case of items other than those identified above, the quality requirements shall be decided based on system design requirements.</p>	
1. Resins / Activated Carbon										Y			
2. Filter Membrane					Y					Y			
3. RO Pressure tube		Y ^a			Y		Y			Y			

CLAUSE NO		QUALITY ASSURANCE											
Items / Components	Test/Check	Material Test	WPS/PQR/Welder	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic test / Pneumatic test / Vacuum test	Performance Test	Test as per relevant Std / Appd. Data Sheets	Other Tests	Remarks	


CHLORINE DI-OXIDE PLANT


1. Horizontal & Vertical Pumps				Y	Y			Y ¹	Y	
1.1. Casing	Y ^a		Y ^b				Y			
1.2. Impeller	Y ^a		Y ^b							Y ^d
1.3. Shaft	Y ^a		Y						Y ^c	
2. Dosing/ Metering Pumps	Y ^a						Y	Y ¹	Y	
3. Acid/Alkali unloading Pumps	Y ^a						Y	Y ¹	Y	
3. Rubber lining	Y ^a				Y				Y	Y ²
4. FRP Tank	Y				Y		Y		Y	Y ³
Note: 1) In case of items other than those identified above, the quality requirements shall be decided based on system design requirements. 2) After erection, the complete Piping system along with valves & fittings shall be hydraulically tested at 1.5 times design pressure or 2 times working pressure whichever is higher.										


LEGENDS: Y Applicable Y ^a One per Heat/Heat Treatment batch./Lot Y ^b On machined surfaces only of castings and forgings. Also 100% after root run/ back gauging for butt welds and 10% after final butt welds and fillet welds. Y ^c UT shall be done for shafts with Dia 40 mm or above & Plates of Thickness 25 mm or above. Y ^d Dynamic Balancing per ISO: 1940, Grade 6.3 minimum. Y ¹ As per HIS, USA/ API 598 (In case of Metering Pump) Y ² Rubber Lining Mix shall be subjected to Bleed Resistance Test on mould sample. Adhesion Test, Spark Test and Hardness Test for the Rubber lined jobs shall also be conducted. Y ³ The test for UV protection shall be carried out and shall be finalized with the approved supplier.

CLAUSE NO.		QUALITY ASSURANCE											
EQUIPMENT COOLING WATER SYSTEM													
TEST / CHECKS		Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Assembly Fit Up	Visual & Dimensional Check	UT	RT	Hydraulic / Water Fill	Balancing	Type Test	Performance Test	Other Test
ITEM / COMPONENTS													
A	PLATE TYPE HEAT EXCHANGER		Y	Y ³	Y	Y			Y				
A.1	Heat Transfer Plates	Y ¹		Y ²		Y							Y ⁷
A.2	Gaskets	Y				Y							
A.3	Cover Plates (Front & Rear)	Y ¹				Y	Y ⁵						
A.4	Tie Rods	Y ¹		Y ⁴			Y ⁶						
B	HORIZONTAL CENTRIFUGAL PUMP				Y	Y						Y ¹⁰	
B.1	Casing	Y ¹		Y ⁴		Y			Y ⁸				
B.2	Impeller	Y ¹		Y ⁴		Y				Y ⁹			
B.3	Shaft	Y ¹		Y		Y	Y ⁶			Y ⁹			
NOTES													
1 One per heat / HT batch													
2 DP Test shall be conducted for 10% of the lot of HT plates. However, in case of any defect, entire lot shall be tested and only defect free plates shall be accepted.													
3 100% DP Test shall be conducted on butt welds and 10% DPT on fillet weld after final run.													
4 100% DPT shall be carried out on machined surfaces.													
5 UT shall be done on plates with thickness >40 mm and for pressure parts plates 25 mm or above.													
6 UT shall be done on shaft / tie rod with diameter 40 mm or above.													
7 After pressing each HT plate shall be subjected to either of the following tests, as per Manufacturer Practice a) Light Box Test b) Vacuum Test c) Air Chamber Test													
8 All pressure retaining parts shall be hydrostatically tested at 200% of pump rated head or 150% of shut – off head, whichever is higher, for at least 30 minutes. No leakage is allowed.													
9 Static and Dynamic Balancing shall be carried out on complete rotor assembly.													
10 All pumps shall be tested at rated speed, for head, flow capacity, efficiency and power consumption for the entire operating range i.e. from shut off head to maximum flow. A minimum of 7 readings shall be taken to plot the curve, with one reading at design flow. Testing standard shall be HIS (Hydraulic Institute Standard) of USA. Performance test shall be carried out with contract motor, wherever Liquidated Damages are to be ascertained based on performance test at shop.													
11. For pipes, fittings, valves & RE joints refer QA chapters of LP Piping.													
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CLAUSE NO.	QUALITY ASSURANCE	<div>एनटीपीसी NTPC</div>		
	<div>AIR CONDITIONINGAND VENTILATION SYSTEM</div> <div><div>1.00.00</div><div>CHILLING UNIT</div><div><div>1.01.00</div><div>Refrigerant Compressor (Screw/Scroll)</div><div><div>1.01.01</div><div>Hydraulic/Pneumatic test of castings of casings shall be carried out. No leakage shall be permitted.</div><div><div>1.01.02</div><div>DPT of screw, impeller, shaft, vanes, casing etc. after machining shall be carried out.</div><div><div>1.01.03</div><div>All rotating parts of screw and centrifugal compressor shall be dynamically balanced to ISO 1940 Gr. 6.3/IS 21940.</div><div><div>1.01.04</div><div>Leak tightness & vacuum check for chilling units / compressor in assembled condition shall be carried out. No leakage shall be permitted.</div><div><div>1.01.05</div><div>Performance test of assembled compressor and Chiller assembly shall be done to check for following :<div><div>i)</div><div>No load air run (free run) test of all types of compressor to check FAD (Free air delivery), Noise, Vibration & Temp. rise of bearing & body.</div><div><div>ii)</div><div>Functional run test for Chiller assembly shall be carried out.</div></div></div></div></div><div><div>1.02.00</div><div>CONDENSER & EVAPORATOR</div><div><div>1.02.01</div><div>DPT shall be carried out on welds if applicable.</div><div><div>1.02.02</div><div>10% RT of butt weld joint on shell shall be carried out if applicable.</div><div><div>1.02.03</div><div>Dimensional check including tube hole dia, ligament, pitch etc. shall be carried out.</div><div><div>1.02.04</div><div>Mock-up test of tubes to tube sheet expansion shall be carried out.In case such test is already carried out for similar tube/tube sheet thickness and materials, records for the same shall be furnished for NTPC review.</div><div><div>1.02.05</div><div>Hydraulic/Pneumatic test of Shell Side and Tube Side of condenser and evaporator as applicable shall be carried out. 'No leakage' shall be permitted.</div></div></div></div><div><div>2.00.00</div><div>AIR HANDLING UNIT</div><div><div>2.01.00</div><div>For Fans refer tests as mentioned at 4.00.00</div><div><div>2.02.00</div><div>One per type of assembled AHU (AHU casing and fan assembly) shall be subjected to free run test. Noise, Vibration and Temp. Rise of bearing shall be measured during run test.</div><div><div>2.01.00</div><div>All cooling coil shall be pneumatically tested and no leakage shall be permitted.</div></div></div></div><div><div>3.00.00</div><div>CENTRIFUGAL PUMP</div><div><div>3.01.00</div><div>UT on pump shaft (dia equal to or above 40 mm) and MPI/DPT on pump shaft and impeller after machining shall be carried out.</div><div><div>3.02.00</div><div>All rotating components of the pumps shall be dynamically balanced to ISO-1940 Gr. 6.3/IS 21940.</div><div><div>3.03.00</div><div>A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut off pressure on the head characteristics curve or twice the rated pressure whichever is higher, for a minimum duration of 30 minutes.</div><div><div>3.04.00</div><div>Standard Running Test</div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div>			
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CLAUSE NO.	QUALITY ASSURANCE		
	<div><div>i)</div><div>All pumps shall be tested in the manufacturer's works preferably with contract motor (or as specified in Engg Tech spec) for capacity, efficiency, head and brake horse power. Pump shall be given running test over the entire operating range covering from the shut-off head to the maximum flow. The duration of test shall be minimum one (1) hr. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and/or as per applicable Indian Standard or equivalent. Acceptance norms shall be as per approved datasheet & HIS standard and/or as per applicable Indian Standard or equivalent only.</div></div> <div><div>ii)</div><div>Noise and vibration shall be measured at shop for reference purpose only.</div></div> <div><div>iii)</div><div>Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and/or excessive vibration are observed during the shop test.</div></div> <div><div>iv)</div><div>NPSH test shall be conducted with water as the medium, if required as per approved data sheets.</div></div>		
4.00.00	FANS:		
4.01.00	20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.		
4.02.00	DPT of fan shafts shall be carried out after machining.		
4.03.00	UT of fan shafts (dia equal to or above 40mm) shall be carried out.		
4.04.00	Rotating components of all fans shall be dynamically balanced to ISO-1940 Gr. 6.3/IS 21490		
4.05.00	All Fans shall be subjected to run test for 4 hrs. or till temperature stabilization is reached. Vibration, Noise level, Temp. rise and current drawn shall be measured during the run test.		
4.06.0	One fan of each type and size will be performance tested as per corresponding BIS code/AMCA for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise.		
5.00.00	LOW PRESSURE AIR DISTRIBUTION SYSTEM		
5.01.00	Functional test for fire damper along with solenoid shall be done.		
5.02.00	Prototype tests report of fire damper (duly approved/accepted by ENGG) for each type and size as per UL-555 for fire rating shall be furnished.		
5.03.00	Site Test- After completion, all ducting system shall be checked/tested for air leakages/tightness (smoke test) at site.		
6.00.00	INSULATION:		
6.01.00	Insulation material shall be tested for all mandatory tests only as per relevant code/standard.		
6.02.00	Resin bonded mineral wool/Glass wool: Thermal conductivity tests (for thermal insulation only) shall be done the same density of material as applicable as per IS:3346 or equivalent standard//Engg spec.		
6.03.00	XLPE/Nitrile Rubber: Thermal conductivity tests (for thermal insulation only) shall be done as per relevant code for the same density and thickness of material and validity of test shall be as per relevant standard/Engg spec.		
7.00.00	COOLING TOWER		
7.01.00	UT of fan shaft and drive shaft (dia equal to or above 40mm) shall be carried out.		
7.02.00	DPT of fan hub and shafts shall be carried out after machining.		
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CLAUSE NO.	QUALITY ASSURANCE		
7.03.00	Color of fills shall be as per approved data sheet.		
7.04.00	Fan assembly shall be statically/dynamically balanced.		
7.05.00	Cooling Towers being supplied to site in assembled condition shall be subjected to run test at shop to measure FAD, Noise & Vibration. For Cooling Towers being supplied in knocked-down condition, these tests shall be done at site		
8.00.00	AIR FILTERS: Pre/Fine filters shall be tested for initial and final pressure drop Vs flow, efficiency and average synthetic dust weight arrestance as per the requirement of BS 6540/ASHARE-52-76/EN779. HEPA (Absolute) filters shall be tested as per applicable code.		
9.00.00	PIPES & FITTINGS:		
9.01.00	All pipes and fittings shall be tested as per applicable codes / standard.		
9.02.00	Site test- Pipes shall be tested at site hydraulically/pneumatically as per application requirement		
10.00.00	VALVES & SPECIALTIES		
10.01.00	Visual and dimensional check of valves as per relevant codes and approved drawing.		
10.02.0	All the water line valves shall be hydraulically tested for body, seat and back seat (wherever provided) as per the relevant standard to which these valves are supplied irrespective of the working pressure for which these valves are selected. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.		
10.03.0	Refrigerant line valves shall be pneumatically tested for body and seat leakage test.		
10.04.00	Valves shall be offered for hydro test and pneumatic test in unpainted condition.		
10.05.0	Functional check of the valves for smooth opening and closing shall be done.		
10.06.0	Performance test to check pressure drop Vs flow shall be carried out for one valve of each type, size and rating for 'Balancing Valve'/Globe Valves with orifice.		
11.00.00	SPLIT, CASSETTE, WINDOW, PRECISION/PACKAGED AC (PAC) & CONDENSING UNITS		
11.01.00	Split/Cassette/ Window AC/PAC will be accepted on the basis of Manufacturer Standard Guarantee and Warrantee certificate.		
11.02.00	PAC/Condensing unit: Each Unit shall be subjected to production routine Test as per relevant standard.		
11.03.00	Capacity, noise level and vibration of PAC/ Condensing unit shall be demonstrated as per relevant standard on one unit of each type and rating.		
12.00.00	Air Washer and Unitary Air Filter (UAF)		
12.01.00	Random 10% DPT on weld joints shall be carried out.		
12.02.00	Hydraulic test of pressure parts at 1.5 times the design or 2 times of working pressure whichever is higher. Pressure and water fill test of tanks shall be carried out.		
12.03.00	Trial assembly of Air washer/UAF for one of each size shall be done in shop.		
12.04.00	Performance test to check pressure drop Vs flow shall be carried out for one Nozzle of each type, size and rating.		
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CLAUSE NO.	QUALITY ASSURANCE	
1.00.00	<u>AIR COMPRESSOR SYSTEM</u>	
1.01.00	AIR COMPRESSORS: <ol style="list-style-type: none"> All pressure parts shall be hydraulically tested at not less than 150% of design pressure prior to painting and lining, if applicable. The test pressure will be maintained for 30 minutes. All other parts including inter-connecting piping shall be hydraulically tested wherever possible, as per relevant codes. Ultrasonic testing shall be carried out on all forgings and shafts (if dia.> 40mm). MPI/DP test will be done on machined areas of the above components. Rotor shall be statically and dynamically balanced as per relevant standard. 	
1.01.01	PERFORMANCE TEST (SHOP TEST) : <ol style="list-style-type: none"> Performance test on the compressors shall be carried out in accordance relevant standard. The test shall also include demonstration of loading and unloading mechanism (Capacity control) and operation of safety valves. Power consumption at motor input terminal at rated capacity as well as at fully unloaded condition of all the compressor shall be measured. Vibration and noise level measurement will be done during shop performance test. Test shall be carried out on all compressors with contract drive motor where power consumption for compressors has been indicated as a guaranteed parameter 	
1.02.00	AIR RECEIVER, HEAT EXCHANGERS, MOISTURE SEPERATORS, AIR DRYING PLANT: <ol style="list-style-type: none"> Each finished vessel shall be hydraulically tested to 150% of the design pressure for a duration of 30 minutes. NDT on weld joints shall be as per respective code requirements or the minimum as specified below: <ol style="list-style-type: none"> 100 % DPT on root run of butt welds. 100% DPT on all finished butt welds and fillet welds 10% RT on butt welds which shall include all T- joints. Tube to Tube sheet joint of the heat exchangers shall be subject to Mock-up test as per the relevant standards. Reactivation blowers shall be tested for FAD, temp. rise noise & vibration. Rotating parts shall be dynamically balanced. Completely assembled ADP shall be pneumatically tested at design pressure for a duration of 5 minutes. Functional and sequential operation testing of the completely assembled ADP shall be demonstrated at shop. Other accessories shall be tested as per relevant code and sections. Dew point measurement shall be done. <p>FOR E.O.T. CRANE REFER QA CHAPTER EOT CRANES AND HOISTS, FOR PIPES, FITTINGS, VALVES & RE JOINTS REFER QA CHAPTERS OF LP PIPING.</p>	
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CLAUSE NO.	TECHNICAL REQUIREMENTS	
1.00.00	FIRE DETECTION & PROTECTION SYSTEM	
1.01.00	HYDRANT SYSTEM: Shop Tests	
1.01.01	Hydrant Valve: <ol style="list-style-type: none"> All valves shall be hydro tested for body and seat. Capacity test / flow test shall be done as per relevant standard. 	
1.01.02	Water Monitor, Hoses, Branch Pipes, Couplings and Nozzles: All tests including hydraulic test shall be done as per relevant Indian / International standard.	
1.01.03	For Pumps, Diesel Engine, refer the requirements are indicated separately.	
1.02.00	HIGH / MEDIUM VELOCITY WATER SPRAY & SPRINKLER SYSTEM: Shop Tests	
1.02.01	For Pipes, Fittings, Valves and specialties, requirements are indicated separately.	
1.02.02	Deluge Valves, Alarm Valves and Spray Sprinkler Nozzles 1.01.03.1 All valves shall be hydro tested for body and seat. 1.01.03.2 Performance test / functional test of 'Deluge Valves', 'Alarm Valves' and 'Spray Nozzles' shall be carried out.	
1.02.03	Detectors: All 'Detectors' shall be tested as per relevant Indian / International Standards. Detectors shall also meet the requirements of UL / FM / LPC/VDS etc.	
1.03.00	HORIZONTAL CENTRIFUGAL PUMP:	
1.03.01	SHOP TESTS <ol style="list-style-type: none"> UT on Pump Shaft ($\geq 40\text{mm}$ dia) and MPI / DPT on Pump Shaft and Impeller shall be carried out. All rotating components of the pumps shall be statically and dynamically balanced as per IS: 21940 Gr. 6.3 or better. Hydraulic test shall be conducted on pump casing with water at 1.5 times the shut off pressure or twice the rated pressure whichever is higher for a minimum duration of 30 minutes. Performance test and Standard Running test: 	
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CLAUSE NO.	TECHNICAL REQUIREMENTS
	<p>1) All the pumps shall be tested in the manufacturer's works for capacity, efficiency, head and brake horsepower. Pump shall be given running test over the entire operating range covering the shut off head to the maximum flow. The duration of test shall be minimum one hour. A minimum of five readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pump shall be in accordance with stipulations oh Hydraulic Institute Standard (HIS) and / or as per applicable Indian Standard or equivalent. Tolerance of parameters shall be as per HIS.</p> <p>2) The test shall be conducted at the rated speed preferably with the type tested contract drive motor being furnished. However, in case of any limitation test bed motor duly calibrated can also be used.</p> <p>3) Noise and vibration shall be measured.</p> <p>4) Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level / vibration performance are observed during the shop test.</p>
1.04.00	COMPRESSION IGNITION DIESEL ENGINE
1.04.01	<p>Shop Tests:</p> <p>a) All pressure parts shall be subjected to hydraulic pressure tests at 1.5 times the design pressure.</p> <p>b) All Diesel engine shall be performance tests as per relevant IS / equivalent code.</p>
1.04.02	<p>Performance Test:</p> <p>Performance test of diesel engine shall be carried out as per BS-5514 to determine the rated power and specific fuel consumption and governor's function.</p> <p>Performance test of engine in shop shall be done with actual job accessories for minimum four hours (three hours for full load and one hour for over load at 110% of full load). All the engine parameters like RPM, inlet airs temp and pressure, water inlet and outlet temp. And pressure, lub. Oil pressure, fuel consumption, ambient condition shall be measured and recorded for every half an hour. No positive tolerance shall be allowed on the specific fuel consumption (contractor to specify in the offer.)</p>
1.05.00	STORAGE VESSELS: Shop Test
1.05.01	<p>Atmospheric Tank</p> <p>a) All weld joints shall be DP Tested and complete tanks shall be water fill tested.</p> <p>b) All atmospheric storage tanks fabricated and erected at site shall be subjected to all tests (Hydro, NDT, and Vacuum) according to design code as applicable.</p>
<p>GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC NO.: CS-6401-001-2</p> <p>VOLUME-VI CHAPTER-Q-02G</p> <p>Page 2 of 4</p>

CLAUSE NO.	TECHNICAL REQUIREMENTS		
1.06.00	PIPING, VALVE AND SPECIALITIES		
1.06.01	SHOP TESTS <ul style="list-style-type: none"> a) All pipes and fittings shall be tested as per applicable code. b) DPT of pipe welds (in case of rolled and welded pipes only) shall be carried out for root and finished welds. c) All strainers shall be subjected to hydraulic pressure test for leakage and Pressure drop v/s Flow for each type and size. d) All valves shall be hydraulically tested for body, seat and back seat (if applicable) as per relevant standard. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure. e) Valves shall be offered for hydro test in unpainted condition. f) Functional checks of the valves for smooth opening and closing shall also be done. g) Anti-corrosive protection shall be tested as per applicable code. 		
1.07.00	PORTABLE & MOBILE FIRE EXTINGUISHERS		
1.07.01	SHOP TEST <ul style="list-style-type: none"> a) All fire extinguishers shall be tested as per relevant standard. b) Performance / function test shall be carried out on sampling basis as per relevant code / standard. 		
1.08.00	EOT Crane		
	<ul style="list-style-type: none"> a) Chain pulley Blocks shall be tested as per IS: 3832. b) Electrical wire rope hoists shall be tested as per IS : 3938 c) Following NDT requirements shall be met: <ul style="list-style-type: none"> (i) 100% RT of Butt welds in tension and 10% RT of butt welds in compression. (ii) DP at random on all weldments. d) Deflection, load, overload & travel check on EOT crane assembly shall be carried out as per IS: 3177. 		
1.09.00	SITE TESTS:		
	<ul style="list-style-type: none"> a) Fire Extinguishers: A performance demonstration test at site of five (5) percent or one (1) number, whichever is higher, of each type and capacity of the extinguisher shall be carried out by the contractor. All consumables and 		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC NO : CS-6401-001-2	VOLUME-VI CHAPTER-Q-02G
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replaceable items require for the contractor without any extra cost to employer would supply this test would be supplied by the Contractor without any extra cost to employer.

b) Piping Protection:

- 1) Thickness, Holiday by spark test, Adhesion test shall be carried out as per relevant standard.
- 2) Complete piping shall be Hydro pressure tested, at 1.5 X DP or 2 X MWP whichever is higher, before protection.

c) Welding of Pipes:


- 1) ERW Black / rolled welded:


100% DPT on root of butt and finish weld of butt and fillet.

RT on 10% randomly selected joints shall be carried out (for underground piping).

- 2) GI Pipes

Welding on GI Pipes in general shall not be done. Welding of GI Pipes, if permitted by design, (butt / socket / fillet weld) shall be done strictly as per approved drawing and procedure approved by NTPC Engineering. For all such welds 100% DP test and random 1% RT shall be done.

CLAUSE NO.	QUALITY ASSURANCE	
	<p style="text-align: center;">Shop Test for EOT, Other Cranes & Hoist</p> <p>1.0 HOOKS</p> <p>1.01 ALL TESTS INCLUDING PROOF LOAD TEST AS PER RELEVANT IS/BS/DIN SHALL BE CARRIED OUT.</p> <p>1.02 MPI/DPT SHALL BE CARRIED OUT AFTER PROOF LOAD TEST.</p> <p>2.0 STEEL CASTING</p> <p>2.01 DPT ON MACHINED SURFACE SHALL BE CARRIED OUT.</p> <p>3.0 GIRDERS, END CARRIAGE, CRAB, GEAR BOX AND ROPE DRUM</p> <p>3.01 THE PLATES OF THICKNESS 25MM AND ABOVE SHALL BE ULTRASONICALLY TESTED.</p> <p>3.02 NDT REQUIREMENTS ON WELDMENTS SHALL BE AS FOLLOWS:</p> <p style="margin-left: 40px;">a) BUTT WELDS IN TENSION:- 100% RT AND 100% DPT</p> <p style="margin-left: 40px;">b) BUTT WELDS IN COMPRESSION:- 10% RT AND 100% DPT</p> <p style="margin-left: 40px;">c) BUTT WELDS IN ROPE DRUM:- 100% RT AND 100% DPT</p> <p style="margin-left: 40px;">d) FILLET WELDS:- RANDOM 10% DPT</p> <p>4.0 FORGING (WHEEL, GEARS, PINIONS, AXLE, HOOKS & HOOK TRUNION)</p> <p>4.01 ALL FORGINGS GREATER THAN OR EQUAL TO 40 MM DIAMETER OR THICKNESS SHALL BE SUBJECTED TO ULTRASONIC TESTING.</p> <p>4.02 DPT/MPI SHALL BE DONE AFTER HARDFACING AND MACHINING.</p> <p>5.0 WIRE ROPE SHALL BE TESTED AS PER RELEVANT STANDARD.</p> <p>6.0 REDUCTION GEARS SHALL BE TESTED FOR REDUCTION RATIO, BACKLASH & CONTACT PATTERN. GEAR BOX SHALL BE SUBJECTED TO NO-LOAD RUN TEST TO CHECK FOR OIL LEAKAGE, TEMPERATURE RISE, NOISE AND VIBRATION.</p> <p>7.0 THE CRANES SHALL BE COMPLETELY ASSEMBLED AT SHOP FOR FINAL TESTING. ALL TESTS FOR DIMENSION, DEFLECTION, LOAD, OVERLOAD, HOISTING MOTION, CROSS TRAVEL ETC. AS PER IS-3177 SHALL BE CARRIED OUT AT SHOP.</p> <p>8.0 ALL ELECTRIC HOISTS SHALL BE TESTED AS PER IS-3938 AND CHAIN PULLEY BLOCKS SHALL BE TESTED AS PER IS-3832.</p> <p>9.0 <u>LIFTING BEAM:</u></p> <p>9.01 THE PLATES OF THICKNESS 25MM AND ABOVE SHALL BE ULTRASONICALLY TESTED.</p>	
<p>GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT</p> <p>(108 MW ±5 MW) EPC PACKAGE</p>	<p>TECHNICAL SPECIFICATIONS</p> <p>SECTION VI, PART- B</p> <p>BID DOC NO.: CS-6400-001-2</p>	<p>VOLUME-VI</p> <p>CHAPTER-Q-03</p> <p>Page 1 of 2</p>

CLAUSE NO.	QUALITY ASSURANCE			
9.02	<p>NDT REQUIREMENTS ON WELDMENTS SHALL BE AS FOLLOWS:</p> <p>e) BUTT WELDS IN TENSION:- 100% RT AND 100% DPT</p> <p>f) BUTT WELDS IN COMPRESSION:- 10% RT AND 100% DPT</p> <p>g) FILLET WELDS:- RANDOM 10% DPT</p>			
9.03	ALL FORGINGS GREATER THAN OR EQUAL TO 40 MM DIAMETER OR THICKNESS SHALL BE SUBJECTED TO ULTRASONIC TESTING.			
9.04	DPT/MPI SHALL BE DONE AFTER MACHINING.			
9.05	Lifting Beam will be subjected to overload testing at @1.25 X SWL of Lifting Beam at manufacturer works.			
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This is an indicative QA check Matrix for the Generator. During Detailed Engineering, QA checks shall be finalized with the successful bidder in line with confirming to the latest edition of relevant Indian/international codes/Indian statutory regulations.

GENERATORS & AUXILIARIES (up to 25MW)**PROCESS CHECK FOR STATIC PARTS GENERATOR / EXCITOR**

ITEM/ COMPONENTS /PROCESS	TESTS	Visual & dimension	Chem. Prop.(raw material)	Heat treatment	Mech.Prop.(raw material as applicable)	Impact (raw material)	Hydraulic test	Pneumatic test	RT/UT (10% for butt weld)	MPI/DPT(All welds of triniun& base plate, sample on other)	Relative permeability	Ferrite content	DIN 43760, IS 2848,7358	DIN 48124
Sheet and Fabrication – Stator Frame, End Shield, Terminal Box etc.		Y	Y	Y	Y	Y	Y1	Y1	Y	Y				
Bearing		Y	Y		Y				Y2					
Terminal Bushing														Y
RTD/ Thermocouple													Y	
Additional checks for											Y			
-Non magnetic Components														
-Non magnetic Components welding												Y		
Y-Test applicable, Y1-For Hydrogen cooled machine, Y2-UT on Babbitt for bearing,														
Note: <ol style="list-style-type: none"> 1- This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. All generators shall be assembled at works and shall be tested to verify/ensure design and workman ship in accordance with IEC-34, VDE 0530, IEEE 115, IEEE 43. The manufacturer shall submit detailed test procedure which clearly specify test set up, instruments to be used, acceptance norms (wherever applicable) recording of different parameter, interval of recording, precautions etc. 3. Cooler, control panel and other auxiliaries (as applicable) to be suitably tested as per tests covered in the specification. 														

**GENERATORS & AUXILIARIES
PROCESS CHECK FOR CORE GENERATOR/EXCITOR**

TESTS ITEM/ COMPONENTS / PROCESS	Specific loss before and after ageing	Magnetization	Anisotropy of losses	Stacking factor	Burr level	chem., elect., viscosity cure time, solid content, dielectric properties	Dimension & surface (uniformity of varnish coat)	Spot weld check
Core lamination	Y	Y	Y	Y			Y	
After punching Insulated core Laminations					Y		Y	
Check for varnish						Y		
Ventilation Stamping								Y
Core assembly							Y	

TESTS ITEM/ COMPONENTS / PROCESS	Process check including Heating & pressure application	Insulation test of insulated core tension bolt & core bar	Functional check of ventilation ducts	Hot spot at rated flux density by infra red camera & ELCID *	Location of temp. detectors	Iron loss at rated flux density
CORE assembly (additional Checks for Generator)	Y	Y	Y	Y	Y	Y

Y-Test applicable

*** In case of any constraint of manufacturer to carry out the test at rated flux , testing at reduced flux as per manufacturer guidelines to be proposed to Owner for review & approval.**

GENERATORS & AUXILIARIES

PROCESS CHECK FOR STATOR CONDUCTOR AND WINDING (GENERATOR/ EXCITOR)

TESTS ITEM/ COMPO-NENTS /PROCESS	Mech. prop (sample)	Chem. prop (sample)	Resistivity/Resistance	Metallography prop.	Insulation adhesion	Flexibility of bending	Dielectric test	Dimension/visual	Electric test	Physical prop.	Brazing procedure	Process check	Check on RTD + location winding
Winding copper and Connecting bus bars	Y	Y	Y	Y									
Insulated conductor					Y	Y	Y	Y					
Insulation material	Y	Y						Y	Y	Y			
Manufacturing Winding bar/coil & phase bar							Y	Y	Y		Y	Y	
Winding laying							Y	Y	Y			Y	Y
Winding support ring		Y						Y		Y			
Connection between bars											Y		

ITEM/ COMPONENTS / PROCESS	TESTS	Tan delta and delta, tan delta Up to 1.2 un	Corona protection resistance	Reactance of stator winding	Dielectric test at elevated And room temp.	Inter strand Insulation test	Slot wedge tightness & radial movement	Type test on two bars for Heating cycle test, Thermal stability test, Voltage endurance test	Support arrangement
Insulated conductor					Y				
Manufacturing Winding bar/coil & phase bar		Y	Y			Y		Y	
Winding laying									Y
Connection between bars/coil						Y1			
wound stator		Y		Y			Y		

Y - Test Applicable,

Y1: As applicable.

GENERATORS & AUXILIARIES
PROCESS CHECK FOR ROTOR AND ASSEMBLY (GENERATOR/EXCITOR)

ITEM/ COMPONENTS / PROCESS	TESTS	Rep. sample tensile stress	Rep. sample 0.2 limit	Rep. sample elongation	Hardness on Sample	Impact check on sample	Rep. sample Chem. prop.	NDTT, FATT (as applicable)	Process check including heat treatment (as applicable)	Ultrasonic test/RT (at suppliers works and after preliminary machining)	Sulphur Prints Check(Depending on proveness)	Flux carrying capacity / Magnetic prop *	Boroscopic Examination
Rotor forging & slip ring shaft		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Rotor end retaining ring, locking ring & Slip ring forgings, diode wheel		Y	Y	Y		Y	Y		Y	Y			
Rotor wedges, damper Wedges.		Y		Y			Y		Y	Y			

Rotor winding copper CC-bolts & D-leads	Y		Y			Y		Y				
Rotor slot boxes/ insulating material						Y						
Rotor winding								Y				
Winding connection studs & assembly												
Complete rotor								Y				
Test on completed rotor at various speed up to rated speed												
Test on completed rotor before & after over speed												
Fan hubs/blades						Y		Y	Y			
GENERATOR assembly												
Diode wheel Assembly												
Permanent magnet					Y						Y	
EXCITER assembly												

Y- Test Applicable

* Not applicable for slip ring shaft of SEE

GENERATORS & AUXILIARIES

PROCESS CHECK FOR ROTOR AND ASSEMBLY (GENERATOR/EXCITOR)

TESTS ITEM/ COMPONENTS /PROCESS	MPI/DP/NDT test	Visual/Dimension/Cleanliness	Adhesion, thickness of Coat on silver plating If applicable	Electrical conductivity and Oxygen content	Mech. test on sample	Electrical test (Σ)	Resistance measurement	Inter turn test	Dielectric test
Rotor forging & slip ring shaft	Y	Y							
Rotor end retaining ring & cover, locking ring & Slip ring forgings, diode wheel	Y		Y						
Rotor winding copper, rotor wedges, damper Wedges, CC-bolts & D-leads	Y		Y	Y1		Y			
Rotor slot boxes/ insulating material					Y	Y			
Coil manufacture		Y							
Rotor winding	Y	Y				Y		Y	Y
Winding connection studs & assembly	Y				Y				Y
Complete rotor							Y		Y
Test on completed rotor at various speed up to rated speed								Y	Y
Test on completed rotor before & after overspeed		Y					Y	Y	Y
Fan hubs/blades	Y	Y							
GENERATOR assembly		Y							
Diode wheel Assembly		Y							
Permanent magnet		Y			Y				
EXCITOR assembly		Y							

Y-Test Applicable , Y1: Oxygen content applicable for Rotor winding copper & D Lead, Σ NOTE- Dielectric test & conductivity test etc. as applicable

GENERATORS & AUXILIARIES

PROCESS CHECK FOR ROTOR AND ASSEMBLY (GENERATOR/EXCITOR)

TESTS ITEM/ COMPONENTS /PROCESS	Insulation Resistance	PI	Radial run out/alignment	Impedance measurement/ RSO (repetitive surge oscillograph)	Dynamic balancing ISO 5406, 2372, 1940	Over speed test (120%) for 2 minute	Axial run out	Metallography examination	Torque on joint bolts	Fitting and locking of Balancing weights	Brazer and brazing procedure
Rotor forging & slip ring shaft								Y			
CC-bolts									Y		
Coil manufacture											Y
Rotor winding											Y
Winding connection studs & assembly	Y										
Complete rotor	Y		Y	Y	Y	Y			Y		
Test on completed rotor at various speed up to rated speed				Y							
Test on completed rotor before & after overspeed	Y		Y	Y							
Fan hubs/blades										Y	
GENERATOR assembly	Y	Y	Y				Y		Y	Y	Y
Diode wheel Assembly			Y				Y		Y	Y	
Permanent magnet											
EXCITOR assembly			Y						Y	Y	

Y-Test applicable

GENERATORS & AUXILIARIES

ADDITIONAL CHECK FOR EXCITOR

TESTS ITEM/ COMPONENTS /PROCESS	Routine Test as per applicable std	As per IEC-76 / Applicable std	Pole parallelism & polarity	Mech. chem. & Magnetic prop (as applicable)	Functional check	Insulation resistance	IEEE/ANSI-C37.18 Or IEC 60947-2	As per applicable standards	As per specification	Dimensional and visual
Fuse diode & filter Circuit	Y									Y
Aux. Transformer (if applicable)		Y								
Carbon brush holder & housing				Y	Y				Y	Y
Cable									Y	
PMG & Exciter stator			Y	Y		Y				
Bandaging wire				Y						
Field discharge resistor					Y					
Bearing, exciter armature field, axis coil , RTD						Y				
Excitation Transformer		Y								
Thyristors									Y	
Field breaker					Y		Y			
Bus duct AC/DC								Y		
Voltage Regulator									Y	
Carbon brush				Y	Y				Y	Y

Y - Test applicable

GENERATORS & AUXILIARIES
FINAL ACCEPTANCE TEST GENERATOR / EXCITOR

ITEM/ COMPONENTS /PROCESS	Resistance measurement	Rotor impedance at various speeds	Heat run test	Function check	Voltage regulation	OCC	SCC	Record Aux. parameters	Steady state reactance' s	Efficiency By separation of losses
Works running test on generator	Y	Y	Y			Y	Y	Y	Y	Y
Without Excitation, Open Circuit & Short Circuit with rated voltage & current for Generator			Y							
Works test on brush less exciter	Y		Y			Y				
PMG works test	Y		Y		Y	Y				
Full load for PMG & convertor assembly			Y							
Convertor assembly for SEE				Y						
Static excitation system				Y						

ITEM/ COMPONENTS /PROCESS	Insulation resistance	Polarisation index	Phase seq. voltage balance	Shaft voltage	H.V. test (except electronic circuit)	RTD, BTD Check	Capacitance measurement	Tan delta, delta tan	Rotor journal	Bearing oil catcher
Works running on generator	Y	Y	Y	Y	Y	Y	Y	Y		
On total wdg / phases at interval 0.2 Un for Generator							Y	Y		
Condition after dismantling									Y	Y
Works test on brush less exciter	Y				Y					
PMG works test	Y		Y		Y					
convertor assembly for SEE	Y				Y					
Static excitation system	Y				Y					

Y - Test Applicable

GENERATORS & AUXILIARIES

FINAL ACCEPTANCE TEST GENERATOR/EXCITOR

TESTS ITEM/ COMPONENTS /PROCESS	Seal rings, liners	Winding Overhang	Vibration measurement	No load	Load characteristics	Characteristics of search coil, quad, axis	Ripple content	As per specification	Visual & dimension	Partial discharge
Works running test on generator			Y						Y	Y
Condition after dismantling	Y	Y								
Works test on brush less exciter			Y	Y	Y	Y			Y	
PMG works test				Y	Y					
Static excitation system							Y	Y	Y	

Y - Test Applicable

CLAUSE NO		QUALITY ASSURANCE													
GENERATOR BUS DUCT & NG EQUIPMENT															
Attributes / Characteristics	Items/Components Sub Systems	Visual & Dimensional Checks	Electrical / Mechanical / Chemical Properties	WPS & PQR	NDT (DP / UT / RT/ MPI)	Painting/ Silver Plating Quality, Thickness & Adhesion Test	Galvanizing Test as per IS: 2629 / 2633 / IS: 6745	Electrical clearance & Creepage distance	Functional/Operational check	Embossing of logo/Batch number	Make / Type Rating / Model / TC / General Physical Inspection	Trial Assembly at works.	Routine Test as per relevant standard / NTPC specs	Test as per IEEE-32 for NGR	IR Measurement before and after HV Test
	Enclosure / Cubicle	Y	Y	Y	Y	Y									
	Bus bar Conductor/Flexible Connector & Disconnecter Link	Y	Y	Y	Y										
	Epoxy Seal-off Bushing, Post/Support Epoxy/Porcelain Insulator as per IS:5621 & 2544	Y	Y							Y			Y		
	Galvanized Steel Structure & Plate	Y					Y								
	Welding on Enclosure & Conductor joint	Y		Y	Y										
	Silver plated connections					Y									
	Elastomer Spring Head, Panel Mounted Items & NG Cubicle	Y							Y		Y		Y		
	Bus Bar Pressurization System	Y							Y				Y		
	Complete Bus Duct & Cubicles	Y				Y		Y				Y	Y		Y
	Complete NGR (IEEE-32)	Y				Y			Y				Y	Y	Y
	Gasket, Silica gel Breather, CT, VT, Surge Capacitor & Arrestor, NGT	Y									Y		Y		
Note: 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the practice and procedure along with relevant supporting documents during QP finalization for all the items. 2) All major Bought Out Items will be subject to NTPC approval. 3) Y-Test applicable															
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2				SUB SECTION Q-05- GEN BUSDUCT & NG EQUIPMENTS,				PAGE 1 OF 1					

GENERATOR TRANSFORMER/ INTERCONNECTING TRANSFORMER/ INTER BUS TRANSFORMER/UNIT TRANSFORMER/STATION TRANSFORMER															
ATTRIBUTES / CHARACTERISTICS															
ITEMS/COMPONENTS SUB SYSTEMS	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	NDT (DPT / RT / UT)	Functional check	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	Isolation test on core/clamp/tank	WPS & PQR	Routine Test as per relevant standard / NTPC Specs	Vacuum & Pressure Test
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y					Y				Y		Y		
Conservator / Radiator / Cooler / Pipes	Y	Y					Y				Y				
Copper Conductor (IS:191)	Y	Y	Y		Y										
Insulating Material	Y	Y	Y	Y	Y	Y									
CRGO Lamination & Built Core	Y	Y	Y		Y	Y					Y				
Porcelain Bushing / Insulator (IS: 2544 / 5621)	Y	Y												Y	
RIP - OIP Bushing (IS 12676, IEC 60137)	Y	Y	Y								Y			Y	
Gasket (IS 2712)	Y	Y			Y	Y			Y						
Air Cell	Y														Y
Transformer Oil									Y					Y	
On Load / Off-Circuit Tap Changer (IEC :214)	Y	Y	Y											Y	Y
Core Coil Assembly & Pre-tanking	Y									Y		Y			
Marshalling Box	Y							Y						Y	
WTI, OTI, MOG, Bucholz Relay, PRD, Thermistor, Breather, Terminal Connector, Bushing CT, Fan & Pumps with Drives, Valves								Y			Y				
Testing & Maintenance equipment											Y				
Welding (ASME Sect-IX)							Y						Y		

GENERATOR TRANSFORMER/ INTERCONNECTING TRANSFORMER/ INTER BUS TRANSFORMER/UNIT TRANSFORMER/STATION TRANSFORMER								
ATTRIBUTE/ CHARACTERISTICS	Oil Leakage Test	Jacking test followed by DP Test on load bearing Member	DGA of Oil for main tank and OLTC Chamber	Measurement of capacitance and tan delta	Di-Electric tests	Routine Test as per relevant standard / NTPC Specs	Nitrogen / Dry Air Dew Point Measurement before final packing on transformer at receipt at site.	Paint Shade Thickness and Adhesion & finish.
ITEMS/COMPONENTS SUB SYSTEMS								
<i>Complete Transformer (IS: 2026 / IEC: 60076)</i>	Y	Y	Y	Y	Y	Y	Y	Y
Note: <ol style="list-style-type: none"> 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items. 2. All major Bought Out Items will be subject to NTPC approval. 3. Read Mechanical strength as mechanical endurance for OLTC/OCTC 4. Y-Test applicable 								

LT INDOOR TRANSFORMER (DRY TYPE)												
ATTRIBUTES / CHARACTERISTICS												
ITEMS/COMPONENTS SUB SYSTEMS	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model / TC / General Physical Inspection	WPS & PQR	Routine Test as per relevant standard	Measurement of capacitance & tan delta between winding	Routine Test
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y						Y				
Copper Conductor	Y	Y	Y		Y							
Insulating Material	Y			Y	Y							
CRGO Lamination & Built Core	Y											
Bushing /Insulator (IS:2544 / 5621)	Y							Y		Y		
Gasket	Y							Y		Y		
Off-Circuit Tap Changer	Y							Y				
Core Coil Assembly	Y						Y					
Marshalling Box	Y									Y		
WTI, Thermistor, Terminal Connector	Y							Y				
Welding									Y			
Complete Transformer (IS:11171 / IEC 60076)	Y										Y	Y
Notes: 1) Transformer Manufacturer has to submit a declaration regarding the compliance of all the in-process checks such as Pocket to Pocket gaps, Centre gap (clearance between inner and outer layer of winding disc), Insulation of tapping leads & bends, brazing, casting parameters as well as all the design margins in line with the type tested similar rating transformer. 2) IR measurement of Shielding screen w.r.t LV, HV and body to be recorded and furnished along with other internal inspection reports. 3) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalization for all items. 4) All major Bought Out Items will be subject to NTPC approval.												

CLAUSE NO	QUALITY ASSURANCE	
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AUXILIARY / LT TRANSFORMER														
ATTRIBUTES / CHARACTERISTICS	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties		Chemical Composition	Compatibility with oil	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	Functional check	WPS & PQR	Routine Test as per relevant standard / NTPC Specification
ITEMS/COMPONENTS SUB SYSTEMS														
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y						Y					Y	
Conservator / Radiator / Cooler / Pipes	Y	Y						Y						
Copper Conductor (IS:191)	Y	Y	Y			Y								
Insulating Material	Y	Y	Y	Y		Y	Y							
CRGO Lamination & Built Core	Y	Y	Y			Y	Y				Y			
Bushing / Insulator (IS:2544 / 5621)	Y	Y									Y			Y
Gasket	Y	Y				Y	Y		Y		Y			Y
Transformer Oil (IEC296)			Y											Y
OLTC / Off-Circuit Tap Changer	Y										Y			Y
Core Coil Assembly & Pre-tanking	Y									Y	Y			
Marshalling Box	Y										Y	Y		Y
WTI, OTI, MOG, PRD, Breather, Terminal Connector, Bucholz Relay, Valves	Y										Y	Y		
Welding (ASME Sect-IX)	Y							Y					Y	
Complete Transformer (IS:2026/ IEC-60076)	Y													Y
Note: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. All major Bought Out Items will be subject to NTPC approval.														

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CABLING, EARTHING, LIGHTNING PROTECTION

ATTRIBUTES / CHARACTERISTICS														
ITEMS/COMPONENTS / SUB SYSTEMS	Dimension	Paint shade, paint thickness, adhesion	Pre-treatment of sheet	IP protection	Proof load*	Surface finish	Deflection test*	HV & IR	Galvanize Test (If Applicable)	Functional	Bought out items/Bill of material	Routine tests as per relevant standard & specification	Acceptance tests as per relevant standard & specification	Constructional feature as per NTPC Specification
Wall Mounted-Lighting Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y		Y	Y	Y	Y	Y
Switch box/junction box/ Receptacles Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y
Cable glands (BS-6121)	Y													Y
Cable lug	Y													Y
Lighting wire (IS-694)	Y											Y		
Flexible conduits	Y											Y		Y
Conduits (Galvanize & Epoxy) IS-9537 & IS-2629, 2633, 6745	Y		Y						Y			Y		Y
RCC Hume Pipe (IS-458)												Y		
Cable termination & straight through joint (IS 13573)	Y											Y		Y
Cable Trays, bends, tees, crosses, Flexible supports system & accessories IS-513, 2629,2633,6745	Y		Y		Y	Y	Y		Y			Y	Y	Y
Trefoil clamp	Y													Y
GI flats for earthing & lighting protection (IS 2062, 2629, 6745,2633)	Y		Y						Y			Y		Y
GI wire (IS-280)	Y											Y		
Fire Sealing System (BS -476)												Y	Y	Y

Note:

- 1) This is an indicative list of tests /checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
- 2) * Deflection Test on cable trays and Proof Load test on cable trays support system will be as per details given in the NTPC technical specification & approved MQP. The above acceptance tests shall be done only on one sample from each size of offered lot. This test is not applicable on bends, tees & crosses.
- 3) Make of all items will be subject to NTPC approval.



LEAD ACID BATTERY								
ATTRIBUTES / CHARACTERISTICS <div style="text-align: center;"> → ↓ </div>	Dimensions & Finish	Conformance to relevant part drg. & Manufacturer' s standards	Chemical composition	Lead Coating Thickness (min. 25 microns, IS: 6848 App.F) & Adhesion Check	Conformance to CPWD Spec. for Teak Wood	Paint Process checks, Paint Shade, Thickness, Adhesion & Finish	Constructional requirements as per NTPC Spec.	Routine & acceptance tests as per relevant standard
ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY								
Container & Lids (IS: 1146)	Y	Y						
Vent Plugs	Y	Y						
Sealing Compound (IS: 3116)		Y	Y					
Positive & Negative Plates		Y	Y					
Separators (IS: 6071)	Y	Y						
Electrolyte (Water / Sulphuric Acid) (IS: 1069 / 266)		Y	Y					
Inter-cell Connectors & Fasteners	Y	Y		Y				
Battery Stand	Y	Y			Y	Y		
Cell Insulators	Y	Y						
Stack Assembly	Y	Y						
Lead Acid Battery (IS: 1652)	Y						Y	Y
Note: This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.								

Ni- Cd BATTERY								
ATTRIBUTES / CHARACTERISTICS <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: right;">→</div> <div style="text-align: left;">↓</div> </div>								
ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimensions & Finish	Impact Strength	Conformance to relevant part drg. & Manufacturer' s standards	Resistance to Alkali	Chemical composition	Nickel Plating thickness	Paint Shade, Thickness, Adhesion & Finish	Routine & acceptance tests as per relevant standard
Container & Lids	Y	Y	Y	Y				
Vent Plugs	Y		Y	Y				
Perforated Steel Strips	Y		Y	Y		Y		
Active Material for Positive & Negative Plates			Y		Y			
Separators	Y		Y	Y				
Electrolyte			Y		Y			
Inter-cell Connectors & Fasteners	Y		Y	Y		Y		
Battery Stand	Y			Y			Y	
Cell Insulators	Y		Y	Y				
Stack Assembly	Y		Y					
Ni-Cd Battery (IS: 10918)	Y							Y
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Makes of all major Bought Out Items will be subject to NTPC approval.								

BATTERY CHARGER															
ATTRIBUTES / CHARACTERISTICS →	ITEMS / COMPONENTS / SUB- ASSEMBLY ↓	Make, Model, Type, Rating & Finish	Verification of Routine test reports as per relevant IS	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard & NTPC spec	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per NTPC approved drgs & specification	Temperature Rise Test	Ripple Content Test, Load Limiter & AVR Operation Test	Dynamic Response Test	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50 ^C for 48 hrs. in energized condition	Alternating current measurement test	Degree of Protection Test as per NTPC Spec.
	Rectifier Transformer and Reactors (IS: 4540, 2026)	Y	Y		Y			Y				Y			
	Electronic Components including Potentiometer (Vernier Type)	Y			Y		Y								
	Electronic Cards	Y			Y								Y		
	PCB & racks for electronic cards	Y					Y								
	Control & Selector Switches (IS: 6875)	Y			Y						Y				
	Indicating Meters (IS: 1248)	Y			Y						Y				
	Indicating Lamps (IS: 13947)	Y			Y						Y				
	Air Break Switches / Fuses (IS: 13947 / 13703)	Y			Y						Y				
	Control Terminal Blocks (IS: 13947)	Y			Y										
	Control Transformer (IS: 12021)	Y			Y						Y				
	Push Buttons (IS: 4794)	Y			Y						Y				
	MCB (IS: 8828)	Y			Y						Y				
	PVC insulated Copper control wires (IS: 694)	Y			Y										
	Sheet Steel (IS: 513)	Y		Y	Y										
	Synthetic Rubber Gaskets	Y			Y										
	Annunciator	Y									Y		Y		
	Battery Charger	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes:

- 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
- 2) Makes of all major Bought Out Items will be subject to NTPC approval.

BATTERY CHARGER (of capacity up to 24 V / 48 V, 150 A DC)										
ATTRIBUTES / CHARACTERISTICS 										
ITEMS / COMPONENTS / SUB- ASSEMBLY 	Make, Model, Type, Rating	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per approved drgs	Ripple Content Test, Load Limiter operation & AVR Operation Test	Operational & Functional Checks of aux. Devices like annunciator, switches, indicators etc.	HV & IR Test	Burn-In Test	Dynamic response test	AC input current measurement test	Temperature rise test
Battery Charger	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Note: 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2) Makes of all major Bought Out Items will be subject to NTPC approval.										

DC HEALTH MONITORING SYSTEM

ITEMS / COMPONENTS / SUB- ASSEMBLY ↓	ATTRIBUTES / CHARACTERISTICS →	Make, Model, Type, Rating & Finish	Verification of Routine test reports as per relevant IS	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard & NTPC spec	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per NTPC approved drgs & specifications	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50°C for 48 hrs in 5energized condition	Degree of Protection Test as per NTPC Spec.
Enclosure		Y		Y	Y	Y					Y
Synthetic Rubber Gaskets		Y			Y						
Control & Selector Switches, Indicating Meters, Indicating Lamps		Y			Y			Y			
Control Terminal Blocks, Push Buttons, MCB		Y			Y			Y			
MCB		Y			Y			Y			
PVC insulated Copper control / signal cables		Y	Y		Y						
Transducers / detectors		Y	Y		Y			Y			
PCB & racks for electronic cards		Y									
Electronic Cards		Y						Y		Y	
Microprocessor Based Controller		Y						Y		Y	
SCADA		Y						Y			
Software		Y						Y			
DC Health Monitoring System		Y			Y	Y	Y	Y	Y	Y	Y

Notes:

- 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
- 2) Makes of all major Bought Out Items will be subject to NTPC approval.

SHUNT REACTOR

ATTRIBUTES / CHARACTERISTICS	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	NDT / DPT / MPI / UT	Ageing Test.	Functional check	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	WPS & PQR	Routine Test as per relevant standard/NTPC specs.	Vacuum & Pressure Test
ITEMS/COMPONENTS SUB SYSTEMS														
Tank	Y	Y					Y					Y		
H.V. & L.V. Cable Box / Flange throat	Y	Y												
Conservator / Radiator / Cooler / Pipes	Y	Y												
Copper Conductor (IS:191)	Y	Y	Y		Y									
Insulating Material	Y	Y	Y	Y	Y	Y								
CRGO Lamination & Built Core	Y	Y	Y		Y	Y								
Porcelain Bushing / Insulator (IS:2544 / 5621)	Y	Y	Y								Y		Y	
RIP/OIP Bushing (IS 12676, IS 2099, IS 3347& IEC 60137)	Y	Y	Y								Y		Y	
Gasket (IS 2712)	Y	Y			Y	Y		Y						
Air Cell	Y													Y
Transformer Oil			Y		Y								Y	
Core Coil Assembly & Pre-tanking	Y									Y				
Marshalling Box	Y	Y					Y		Y		Y		Y	
WTI, OTI, MOG, PRD, Thermistor, Breather, Terminal Connector, Fan & Pumps with Drives, Valves, Bucholz Relay									Y		Y			
Welding (ASME Sect-IX)							Y					Y		

SHUNT REACTOR											
ATTRIBUTE/ CHARACTERISTICS											
ITEMS/COMPONENTS SUB SYSTEMS	Oil Leakage Test	Jacking test followed by DP Test on load bearing Member	DGA of Oil for main tank	Measurement of capacitance and tan delta	Di-electric Tests	Switching impulse test on line terminal	Nitrogen / Dry Air Dew Point Measurement before final packing on transformer at receipt at site.	Lighting Impulse Test on all phases	Vibration and stress measurement test	Routine Test as per relevant standard/NTPC Spec.	Paint Shade, Thickness, Adhesion and finish.
Complete Shunt Reactor (IS:5553 -I / IEC: 289 & 76)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Note: 1) This is an indicative list of test/checks. The manufacture is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalization for all items. 2) All major Bought Out Items will be subject to NTPC approval. Y-Test applicable											


CONSTRUCTION POWER - RING MAIN & LT S/S & HT Lines

<div style="display: flex; justify-content: space-between;"> <div style="transform: rotate(-45deg);">Attributes / Characteristics</div> <div style="transform: rotate(45deg);">Items / Components / Sub System Assembly</div> </div>									
	Dimensions & finish	Make, Model, Type, Rating & TC	Item to conform to relevant standards	Functional & Operational features as per NTPC spec.	Galvanizing Tests	Pretreatment as per IS 6005	Paint shade, thickness, adhesion & finish	Functional Checks	All Routine / Acceptance Tests as per NTPC Spec. & IS
HT AC Switch Outdoor type (IS: 9920)	Y	Y	Y	Y		Y	Y	Y	Y
Outdoor HT Fuse & Fuse base (IS : 9385) / Drop Out Fuse Assembly	Y	Y	Y	Y				Y	Y
HT Outdoor Type Lightning Arrester (IEC : 99 - 4)	Y	Y	Y						Y
ONAN Transformer (IS 2026)	Y	Y	Y						Y
LT Power Control Centers (IS 8623)	Y	Y	Y						Y
Distribution Boards / Fuse Boards (IS 8623)	Y	Y	Y						Y
HT armored Cable (IS : 7098)	Y	Y	Y						Y
LT armored Power & Control cable (IS : 1554)	Y	Y	Y						Y
Cable Termination Kits and Straight Through Joints (VDE 0278)	Y	Y	Y						Y
ACSR Conductor (IS : 3835)	Y	Y	Y						Y
Earth wire & Guy wire/ Stay set (IS : 6594)	Y	Y	Y						Y
Galvanized Steel Structure (IS 2633 / 2629 / 6745 / 802)	Y	Y	Y		Y				Y
Steel Tubular Poles (IS 2713)	Y	Y	Y			Y	Y		Y
Rail Poles (IRS : 90 L)	Y	Y	Y			Y	Y		Y
ISMC Channel / Angle / Flat (IS 2062)	Y	Y	Y						
Hardware (IS 1367)	Y	Y	Y						
Disc & Pin Insulator (IS 731)	Y	Y	Y						Y
Strain Porcelain Insulator (IS 5300)	Y	Y	Y						Y
Suspension / Tension Clamp for Earth wire (IS 398 Pt 2)	Y	Y	Y						Y
Hardware for insulator (IS 2586)	Y	Y	Y						Y
Vibration damper (IS 9708)	Y	Y	Y						Y
LT Air Circuit Breaker (IS : 13947)	Y	Y	Y	Y				Y	Y
LT CT / PT (IS : 2705 / 3156)	Y	Y	Y						Y
MCB (IS : 8828)		Y	Y	Y				Y	Y
MCCB (IS : 13947)		Y	Y	Y				Y	Y
Air Break Switch / LT Fuse (IS : 13947 / 13703)		Y	Y	Y					Y
Control & Selector Switches (IS : 6875)		Y	Y	Y				Y	Y
CT / PT (IS : 2705 / 3156)		Y	Y	Y				Y	Y
Energy Meters (IS 722)		Y	Y	Y				Y	Y
Indicating meters (IS : 1248)		Y	Y	Y				Y	Y
Push Buttons (IS : 4794)		Y	Y	Y				Y	Y


<div style="text-align: center;"> Attributes / Characteristics ↘ </div> <div style="text-align: center;"> Items / Components / Sub System Assembly ↙ </div>	Dimensions & finish	Make, Model, Type, Rating & TC	Item to conform to relevant standards	Functional & Operational features as per NTPC spec.	Galvanizing Tests	Pretreatment as per IS 6005	Paint shade, thickness, adhesion & finish	Functional Checks	All Routine / Acceptance Tests as per NTPC Spec. & IS
Indicating Lamps (IS: 13947)		Y	Y	Y				Y	Y
PVC insulated copper wires (IS : 694)		Y	Y	Y					Y
Cable Lugs / Cable Glands (IS 8309 / BS 6121)		Y	Y	Y					Y
Lighting Fixtures (IS 10322)	Y	Y	Y						Y
GI Pipe for Earthing (IS : 2629 / 2633 / 4749)	Y	Y	Y		Y				
Fence (IS : 278)		Y	Y						
Danger Plate (IS 2551)			Y						Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to NTPC approval.

CLAUSE NO	QUALITY ASSURANCE	
<div>SPV MODULE</div>		
<p>This is indicative List of tests/ checks. The manufacturer is to furnish a detailed quality Plan indicating the practice & procedure along-with the relevant supporting documents.</p>		
<div>1. PCU-</div> <div>A) Incoming Quality Checks on bought out items</div> <div>B) In-process quality checks</div> <div>C) Routine tests as per following on the assembled PCU:</div> <div><div>1) Test to demonstrate automatic / manual synchronization and connection to utility service</div><div>2) Functional check on all protections</div><div>3) Check on accuracy of all parameters measured by PCU</div><div>4) Test to demonstrate operation of start-up, stable operation of the PCU, disconnection and shutdown controls and response to other control signals</div></div> <div>D) Following sample tests assembled PCU: (1 Unit per offered lot)</div>		
<p>Heat run test including measurement of phase currents, efficiencies, harmonic content and power factor at four points preferably 25, 50, 75 and 100% of the rated nominal power.</p>		
<div>2. SPV module-</div> <div>SPV modules quality plan should include the following:</div> <div>A) Incoming Quality Checks on bought out items (listed in third party test reports of relevant standard)</div> <div>B) In-process Quality Checks</div> <div>C) Final Inspection sample tests as per following:</div> <div><div><div>1) SPV modules to be checked visually for following defects: (sampling as per General Inspection Level II and AQL 1.5% as per IS 2500 Part 1)</div><div><div>a) Scratches on the frame and/or glass</div><div>b) Excessive or uneven glue marks on glass or frame</div><div>c) Inconsistent cell colours</div><div>d) Completeness of module in all respects</div></div></div><div>2) Performance of SPV module at STC (sampling as per General Inspection Level II and AQL 1.5% as per IS 2500 Part 1)</div><div>3) IR-HV-IR test (sampling as per General Inspection Level II and AQL 1.5% as per IS 2500 Part 1)</div><div>4) Robustness of terminations on 1 sample per offered lot</div><div>5) Mechanical load test on 1 sample per offered lot</div></div>		
<div>3. Array Junction Box / String Monitoring Box-</div> <div>Array Junction quality plan should include the following:</div> <div>A) Checks on bought out items as per internal standards of the manufacturer</div> <div>B) In-process checks, as per internal standards of the manufacturer</div> <div>C) Sample tests as per following:</div> <div><div><div>1) IR-HV-IR test (sampling as per General Inspection Level-II and AQL 1.5% as per IS 2500 Part 1)</div><div>2) String Monitoring Card/ Power Supply card/ DC-DC Converter function check on one sample of SMB (In case of String Monitoring Box only)</div><div>3) Communication Function Test on one sample (In case of String Monitoring Box only)</div><div>4) Degree of protection visual checks like gasket profile, sealing arrangement, paper pull check</div></div></div>		
<div>4. DC Cable-</div> <div>Routine and Acceptance Test as per the relevant Standard applicable as per technical specifications.</div>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC NO.: CS-6401-001-2	SUB-SECTION Q-09B-SPV MODULE
		PAGE 1 OF 1


CLAUSE NO	QUALITY ASSURANCE										<div>एनटीपीसी NTPC</div>		
DIESEL GENERATOR SET													
DIESEL ENGINE													
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	TESTS/ CHECKS	Material Test	DP/MPI	UT (On forging and piston Bonding)	Balancing	Hydraulic/water fill test	Assy./fit up	Dimension	Functional/Operation test	Performance test as per BS-5514/or equivalent IS/ISO-Standard including Governing Test for 3 hours at full load	Fuel consumption, rated power measurement, rated speed	All other tests (if applicable) as per Spec./ relevant	
	Crank shaft	Y	Y	Y	Y								
	Cylinder blocks/heads	Y				Y							
	Liner/ Radiator	Y				Y							
	Rotating/moving parts other than crank shaft	Y	Y										
	Piston	Y	Y	Y									
	Diesel Engine						Y	Y	Y	Y	Y	Y	
	Note: 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2) All major Bought Out Items will be subject to NTPC approval.												
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE				TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC NO.: CS-6401-001-2				SUB SECTION Q-10-DG SET			PAGE 1 OF 4		

CLAUSE NO	QUALITY ASSURANCE																	
ALTERNATOR																		
TESTS/ CHECKS	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing (WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All Routine tests as per IS- /IS- 4722	Vibration	Over speed	Tan delta, shaft voltage & polarization index test
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY																		
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y									
Shaft	Y	Y	Y	Y	Y	Y			Y									
Magnetic Material	Y	Y	Y	Y	Y		Y			Y		Y						
Rotor Copper/Aluminum	Y	Y	Y	Y		Y	Y		Y									
Stator copper	Y	Y	Y	Y			Y		Y			Y						
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y									
Insulating Material	Y		Y	Y			Y					Y						
Tubes for Cooler	Y	Y	Y	Y	Y				Y		Y							
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y							
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y										
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y										
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y				Y									
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE			TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC NO.: CS-6401-001-2					SUB SECTION Q-10-DG SET						PAGE 2 OF 4				

CLAUSE NO	QUALITY ASSURANCE																	<div>एनटीपीसी NTPC</div>																																																																																																																																																									
<div>ALTERNATOR</div> <table><tr><th>ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY</th><th>Visual</th><th>Dimensional</th><th>Make/Type/Rating/TC/General Physical Inspection</th><th>Mech/Chem. Properties</th><th>NDT /DP/MPI/UT</th><th>Metallography</th><th>Electrical Characteristics</th><th>Welding/Brazing (WPS/PQR)</th><th>Heat Treatment</th><th>Magnetic Characteristics</th><th>Hydraulic/Leak/Pressure Test</th><th>Thermal Characteristics</th><th>Run out</th><th>Dynamic Balancing</th><th>All Routine tests as per IS-4722</th><th>vibration</th><th>Over speed</th><th>Tan delta, shaft voltage & polarization index test</th></tr><tr><td>Wound stator</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Wound Exciter</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Rotor complete</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td></tr><tr><td>Exciter, Stator, Rotor, Terminal Box assembly</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Accessories, RTD, BT, CT, AVR, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.</td><td>Y</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Alternator (IS 4722)</td><td>Y</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Y</td><td>Y</td><td>Y</td><td>Y1</td></tr><tr><td colspan="19"><div>Note:</div><div>1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalization.</div><div>2) Make of all major BOIs will be subject to NTPC approval.</div><div>Y1= for HT Machines only.</div></td></tr></table>																				ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing (WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All Routine tests as per IS-4722	vibration	Over speed	Tan delta, shaft voltage & polarization index test	Wound stator	Y	Y					Y	Y											Wound Exciter	Y	Y					Y	Y											Rotor complete	Y	Y					Y						Y	Y					Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y												Accessories, RTD, BT, CT, AVR, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y																Alternator (IS 4722)	Y	Y	Y												Y	Y	Y	Y1	<div>Note:</div> <div>1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalization.</div> <div>2) Make of all major BOIs will be subject to NTPC approval.</div> <div>Y1= for HT Machines only.</div>																		
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing (WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All Routine tests as per IS-4722	vibration	Over speed	Tan delta, shaft voltage & polarization index test																																																																																																																																																									
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Rotor complete	Y	Y					Y						Y	Y																																																																																																																																																													
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y																																																																																																																																																																				
Accessories, RTD, BT, CT, AVR, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y																																																																																																																																																																								
Alternator (IS 4722)	Y	Y	Y												Y	Y	Y	Y1																																																																																																																																																									
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GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE				TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC NO.: CS-6401-001-2				SUB SECTION Q-10-DG SET				PAGE 3 OF 4																																																																																																																																																															

CLAUSE NO	QUALITY ASSURANCE										<div>एनटीपीसी NTPC</div>																																																																																																											
<table><tr><th colspan="11">FINAL ASSEMBLY</th></tr><tr><th>ITEMS/COMPONENTS</th><th>TESTS/ CHECKS</th><th>Material Test</th><th>Dimension</th><th>WPS/PQR/Welding</th><th>NDT/DP/MPI/UT</th><th>Check completeness</th><th>Hydraulic/Leak/Pressure test</th><th>Functional Tests</th><th>All routine test as per Spec/ IS</th><th>No load test for 5 min & partial loads for one hour of the DG set assembly</th><th>Clearances & Alignment</th></tr><tr><td>Base frame</td><td></td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Fuel Tank</td><td></td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td></tr><tr><td>Battery</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Y</td><td></td><td></td></tr><tr><td>Battery Charger</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Y</td><td></td><td></td></tr><tr><td>Control Panel</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Y</td><td></td><td></td></tr><tr><td>Assembled DG Set</td><td></td><td></td><td>Y</td><td></td><td></td><td>Y</td><td></td><td>Y</td><td></td><td>Y</td><td>Y</td></tr><tr><td colspan="12"><div>NOTES:</div><div>1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during finalization of QP.</div><div>2) Make of all major Bought Out Items will be subject to NTPC approval.</div></td></tr></table>												FINAL ASSEMBLY											ITEMS/COMPONENTS	TESTS/ CHECKS	Material Test	Dimension	WPS/PQR/Welding	NDT/DP/MPI/UT	Check completeness	Hydraulic/Leak/Pressure test	Functional Tests	All routine test as per Spec/ IS	No load test for 5 min & partial loads for one hour of the DG set assembly	Clearances & Alignment	Base frame		Y	Y	Y	Y	Y						Fuel Tank		Y	Y	Y	Y	Y	Y					Battery									Y			Battery Charger									Y			Control Panel									Y			Assembled DG Set			Y			Y		Y		Y	Y	<div>NOTES:</div> <div>1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during finalization of QP.</div> <div>2) Make of all major Bought Out Items will be subject to NTPC approval.</div>											
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GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE			TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC NO.: CS-6401-001-2			SUB SECTION Q-10-DG SET			PAGE 4 OF 4																																																																																																													

CLAUSE NO		QUALITY ASSURANCE																<div>एनटीपीसी</div> <div>NTPC</div>			
MOTOR																					
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY		TESTS/ CHECKS	Visual	Dimensional	Make/Type/Rating /General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing (WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	Routine & Acceptance tests as per IS-4722 /IS- 9283/ IS2148/ IEC60034/ IEC 60079-I/ IS-12615	vibration	Over speed	Tan delta, shaft voltage & polarization index test	Paint shade, thickness & adhesion
Plates for stator frame, end shield, spider etc.		Y	Y	Y	Y	Y					Y										
Shaft		Y	Y	Y	Y	Y	Y				Y										
Magnetic Material		Y	Y	Y	Y				Y			Y		Y							
Rotor Copper/Aluminium		Y	Y	Y	Y				Y		Y										
Stator copper		Y	Y	Y	Y				Y		Y			Y							
SC Ring		Y	Y	Y	Y	Y			Y	Y	Y										
Insulating Material		Y		Y	Y				Y					Y							
Tubes, for Cooler		Y	Y	Y	Y	Y					Y		Y								
Sleeve Bearing		Y	Y	Y	Y	Y					Y		Y								
Stator/Rotor, Exciter Coils		Y	Y	Y					Y	Y											
Castings, stator frame, terminal box and bearing housing etc.		Y	Y	Y	Y	Y				Y											
Fabrication & machining of stator, rotor, terminal box		Y	Y			Y				Y	Y										
Wound stator		Y	Y						Y	Y											
Wound Exciter		Y	Y						Y	Y											
Rotor complete		Y	Y						Y						Y	Y					
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE			TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC NO.: CS-6401-001-2							SUB SECTION Q-11- MOTORS						PAGE 1 OF 2					

CLAUSE NO		QUALITY ASSURANCE																	
Exciter, Stator, Rotor, Terminal Box assembly		Y	Y					Y											
Accessories, RTD, BTD, CT, Space heater, antifriction bearing, gaskets etc.		Y	Y	Y															
Complete Motor		Y	Y	Y											Y	Y	Y	Y1	Y
<p>Note:</p> <p>1) The manufacturer is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization. However, following methodology to be followed for Inspection Categorization:</p> <p>Note for LT Motor:</p> <p>i. Motor rating up to 50 KW: Inspection CAT- III: Acceptance of Motor up to 50 KW is based on COC of the Manufacturer and Main Contractor confirming as follows: “It is hereby confirmed that the above-mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage frequency variation, hot starts, pull out torque, starting KVA/KW, temperature rise, distance between center of stud gland plate and tested in accordance with approved drawing /data sheets.”</p> <p>ii. ii) Motor rating above 50 KW & less than 75 KW: Inspection CAT- II as per NTPC approved MQP: Acceptance of Motor rating above 50 KW & less than 75 KW is based on NTPC review of Routine Test inspection report as per IS:12615 - 2018 (including latest revision) duly witnessed by main contractor along with COC of the Manufacturer and Main Contractor confirming as follows: “It is hereby confirmed that the above-mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage frequency variation, hot starts, pull out torque, starting KVA/KW, temperature rise, distance between center of stud gland plate, space heater and tested in accordance with approved drawing /data sheets.”</p> <p>iii. iii) Motor rating 75 KW & above: Inspection CAT-I: As per NTPC approved MQP.</p> <p>2) Additional routine tests for Flame proof motors shall be applicable as per relevant standard.</p> <p>3) Makes of major bought out items for HT motors will be subject to NTPC approval.</p> <p>4) Y1 = for HT Motor / Machines only.</p> <p>5) For LT Motors, stator core stack length & grade, no load loss and winding resistance w.r.t. type tested motor for IE2/IE3 shall be checked/verified in addition to Compliance of relevant standard IS:12615/IEC requirement. In case actual results are not within the tolerance limit as declared by manufacturer during QP submission, the motor shall be subjected to efficiency test.</p>																			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE					TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC NO.: CS-6401-001-2					SUB SECTION Q-11- MOTORS					PAGE 2 OF 2				

CATHODIC PROTECTION


Attributes /Characteristics Items, Components, Sub-System Assembly	Make, type, model, rating & TC	Visual Check	Electrical Properties	Mechanical Properties	Chemical Properties	Dimension and Finish	Functional & Operational Feature	Painting as per tech specs.	All Routine and Acceptance test s as per relevant standards/tech Specs
TR unit	Y	Y	Y			Y	Y	Y	Y
Silicon Chromium Anode	Y	Y		Y	Y	Y		Y	
Junction Box	Y	Y	Y			Y		Y	Y
Permanent Reference Cell(Cu-CuSO4)	Y	Y				Y			
Sacrificial Magnesium Anode	Y	Y		Y	Y	Y		Y	Y
Zinc Anode	Y	Y		Y	Y	Y		Y	Y
MMO Anode	Y	Y	Y	Y	Y	Y	Y	Y	Y
Surge Diverter	Y	Y	Y		Y	Y			Y
ER Probe and Reader	Y	Y				Y			Y
Polarization Cell	Y	Y	Y		Y	Y			Y
Cables	Y	Y	Y	Y		Y			Y
Test Station	Y	Y						Y	Y


NOTE:


- This is an indicative list of tests/ checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant and supporting documents.
- Make of all Bought Out Items will be subject to NTPC approval


STATION LIGHTING


ATTRIBUTES/ CHARACTERISTICS ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Make, Type, Rating/ TC	Dimension	Pre-Treatment of sheet	Paint Shade Thickness Adhesion & Finish	Galvanization Tests	IP Test	Bought Out Items/ Bill of Material	HV & IR	Functional Check as per spec.	Constructional Feature as per NTPC spec.	Routine Test as per relevant std and spec	Acceptance Test as per relevant std and spec	Item to conform to relevant standard
Luminaries (IS-10322 Part-5 Sec.1 (non -LED type)	Y					Y		Y			Y	Y	Y
Electronic Ballast	Y										Y	Y	Y
Lighting Wire (IS-694)	Y										Y		
Fans (IS-374)	Y										Y		
Pole (IS-2713)	Y			Y						Y	Y	Y	
Lamps (IS-9800, IS-9974)	Y										Y	Y	
Lighting Mast (with raise & lower lantern type)	Y	Y			Y					Y	Y	Y	
Wall Mounted Lighting Panel (IS-513, IS-5)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Switch Box/ Junction Box/Receptacles/ Local Push Button Station / Lighting Panel (IS-513, 2629, 2633, 4759, 6745)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Cable Gland (BS-6121)	Y	Y									Y		
Cable Lug (IS-8309)	Y	Y									Y		
Flexible Conduit	Y										Y		
Lighting Transformer (IS-11171)	Y									Y	Y		
Epoxy & Galvanized Conduit (IS-9537, 2629, 2633, 4759, 6745)	Y	Y									Y		Y


CLAUSE NO	QUALITY ASSURANCE		
	<p>LED Luminaire quality requirements:</p> <ol style="list-style-type: none"> 1) LED modules to conform to IS: 16103 part 2. Manufacturer to issue a certificate of compliance for the same. 2) Control gear to conform to IS 15885-part 2 section 13. Manufacturer to issue a certificate of compliance for the same. 3) LED luminaire to conform to IS 16107-part 2 section 1. Manufacturer to issue a certificate of compliance for the same. 4) LED luminaire marking to be as per IS 16107-part 2 section 1. Manufacturer to issue a certificate of compliance for the same. 5) Acceptance tests as per IS 16107-part 2 section 1 to be carried out on LED luminaire except long duration tests i.e., a) Chromaticity coordinates & correlated color temperature (CCT); b) Color rendering index (CRI). Manufacturer will submit a COC for above tests i.e., CCT & CRI 6) LED drivers make, model, type & rating may be as per recommendations of LED module manufacturer. <p>Notes:</p> <ol style="list-style-type: none"> 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Make of all major Bought Out Items will be subject to NTPC approval. 		
<p>GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC NO.: CS-6401-001-2</p>	<p>SUB SECTION Q-13- STATION LIGHTING</p>	<p>PAGE 2 OF 2</p>

CLAUSE NO	QUALITY ASSURANCE																	
MV (3.3 KV / 6.6. KV / 11 KV / 33 KV) CABLES																		
ATTRIBUTES / CHARACTERISTICS	ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Make, Type & T.C as per relevant standard	Dimension/surface finish	Mechanical properties	Chemical Composition	Spark Test (as applicable)	Electrical properties	Hot Set Test/ Eccentricity & Ovality	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two wires	Sequential marking/ Batch marking/ surface finish/ cable length	T.S & elongation before & after ageing on outer sheath & insulation	Thermal stability on outer	Metallic (Cu) Screening (If applicable)	Anti-termite coating on wooden drums	Constructional requirements feature as per specification	Routine & Acceptance Test as	FRLS Test
	Aluminum (IEC 60228)	Y	Y	Y	Y		Y											
	Semiconducting Compound	Y		Y			Y											
	XLPE Compound (IEC 60502-2 (2005))	Y		Y			Y					Y						
	FRLS PVC Compound (IEC-60754 Part-1)	Y		Y								Y	Y					Y
	Triple Extrusion & curing /Manufacturing of Core		Y			Y		Y										
	Copper Tape	Y	Y	Y			Y											
	Polyester tape	Y	Y															
	Core Laying								Y									
	Armor wire/strip	Y	Y	Y														
	Copper tapping	Y	Y											Y				
	Inner sheath	Y	Y															
	Armoring		Y							Y								
	Outer Sheathing		Y								Y							
	Power Cable (Finished)								Y	Y	Y	Y	Y			Y	Y	Y
	Wooden drum (relevant standard) /Steel Drum		Y												Y	Y		
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Make of all major Bought out items will be subject to Owner's approval.																		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION - VI BID DOC. NO: CS-6401-001-2					SUB SECTION Q-14-HT CABLES					PAGE 1 OF 4						


CLAUSE NO	QUALITY ASSURANCE		
ROUTINE TESTS		Following routine tests shall be carried out on each drum of finished cables for all types & sizes.	
1)		Conductor Resistance test	
2)		High voltage test	
3)		Partial discharge test (for Screened cables only)	
ACCEPTANCE TESTS		Following Acceptance tests shall be carried out on each size of each type (voltage rating) of cables, in the offered lot.	
A) For Conductor (as per sampling plan mentioned in IEC 60502-2 (2005))			
		1)	Annealing test (Copper)
		2)	Tensile Test (Aluminum)
		3)	Wrapping Test (Aluminum)
		4)	Resistance test
B) For copper tape / Wires (as per sampling plan mentioned in IEC 60502-2 (2005))			
		1)	Measurement of Dimensions
		2)	Conductivity check
B) For Armour Wires / Formed Wires (If applicable) (as per sampling plan mentioned in IEC 60502-2 (2005))			
		1.	Measurement of Dimensions
		2.	Tensile Tests
		3.	Elongation Test
		4.	Torsion Test for Round wires only
		5.	Wrapping Test
		6.	Resistance Test
		7.	Mass of Zinc coating test For G S wires / Formed wires only
		8.	Uniformity of Zinc coating For G S wires / Formed wires only
		9.	Adhesion test For G S wires / Formed wires only
		10.	Freedom from surface defects
C) For XLPE insulation & PVC Sheath (as per sampling plan mentioned in IEC 60502-2 (2005))			
		1)	Test for thickness
		2)	Tensile strength & Elongation before ageing (for tests after ageing see “D”)
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION - VI BID DOC. NO: CS-6401-001-2	SUB SECTION Q-14-HT CABLES
		PAGE 2 OF 4	

CLAUSE NO		QUALITY ASSURANCE			
	3)	Hot set test	(For XLPE insulation)		
D) Ageing test:					
If the compound manufacturer is carrying out Ageing test, test report of compound manufacturer is to be reviewed. If the compound manufacturer is not carrying out ageing test, then cable manufacturer will carry out ageing test & the test report will be reviewed by owner (quantum of ageing test sample shall be one sample /batch)					
(a) In case of manufacturers / supplier who have supplied cables in the past through Corporate Centre: - Routine Test of manufacturer internal test reports are to be verified by owner and Main Contractor at the time of final inspection. Owner and Main Contractor will also witness routine tests on cables on 10% sample basis.					
(b) In case of manufacturers / supplier WHO HAVE NOT SUPPLIED cables in the past through Corporate Centre: - Routine Test of manufacturer internal test reports are to be verified by Owner at the time of final inspection. Owner will witness routine tests on cables for the first order on 10% sample basis and Main Contractor will witness routine tests on cables for the first order on 100% basis.					
1. For Smoke Density rating test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.					
2. For Acid Gas Generation test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.					
3. For Oxygen Index test: if the test result without conditioning is within (+)7% of the minimum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.					
4. In case the test results without conditioning do not meet the maximum/minimum specified value, the manufacturer may exercise the option of retesting the samples after conditioning as per standard.					
E) Following tests will be carried out on completed cables as per relevant standard on each size of each type					
	1)	Insulation resistance test (Volume resistivity method)			
	2)	High voltage test			
	3)	Partial discharge test (for Screened cables only)			
F) Following tests shall be carried out on only one size of offered lot (comprising of all sizes & types)					
	1)	Thermal stability test on outer sheath			
	2)	Oxygen index test on outer sheath			
	3)	Smoke density rating test on outer sheath			
	4)	Acid gas generation test on outer sheath			
	5)	Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cable			
G) Following tests shall be carried on one length of each size of each type of offered lot:					
	1)	Constructional / dimensional check, surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Sequential marking, marking of drum no. / Batch number of outer sheath extrusion			
	2)	Measurement of Eccentricity & Ovality			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION - VI BID DOC. NO: CS-6401-001-2		SUB SECTION Q-14-HT CABLES PAGE 3 OF 4	

CLAUSE NO	QUALITY ASSURANCE		
GENERAL NOTE:			
(a) In case of manufacturers / supplier who have supplied cables in the past through Corporate Centre: - Routine Test of manufacturer internal test reports are to be verified by owner and Main Contractor at the time of final inspection. Owner and Main Contractor will also witness routine tests on cables on 10% sample basis.			
(b) In case of manufacturers / supplier WHO HAVE NOT SUPPLIED cables in the past through Corporate Centre: - Routine Test of manufacturer internal test reports are to be verified by Owner at the time of final inspection. Owner will witness routine tests on cables for the first order on 10% sample basis and Main Contractor will witness routine tests on cables for the first order on 100% basis.			
1. For Smoke Density rating test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.			
2. For Acid Gas Generation test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.			
3. For Oxygen Index test: if the test result without conditioning is within (+)7% of the minimum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.			
4. In case the test results without conditioning do not meet the maximum/minimum specified value, the manufacturer may exercise the option of retesting the samples after conditioning as per standard.			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI BID DOC. NO: CS-6401-001-2	SUB SECTION Q-14-HT CABLES PAGE 4 OF 4

CLAUSE NO	QUALITY ASSURANCE																
LT POWER CABLES & CONTROL CABLES																	
ATTRIBUTES / CHARACTERISTICS	ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Make, Type & T.C as per relevant standard	Dimension/surface finish	Mechanical properties	Chemical Composition	Spark Test (as applicable)	Electrical properties	Hot Set Test/ Eccentricity & Ovality	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two wires	Sequential marking/ Batch marking/ surface finish/ cable length	T.S & elongation before & after ageing on outer sheath & insulation	Thermal stability	Anti-termite coating on wooden drums	Constructional requirements feature as per specification	Routine & Acceptance Tests as per relevant standard & specification	FRLS Tests
	Aluminum (IEC 60228)	Y	Y	Y	Y		Y										
	Copper (IEC 60228)	Y	Y	Y	Y		Y										
	XLPE Compound (IEC 60502-2 (2005))	Y		Y			Y	Y				Y					
	PVC insulation Compound (IEC 60502)	Y		Y			Y					Y	Y				
	FRLS PVC Compound (IEC-60754 Part-1)	Y		Y								Y	Y				Y
	Extrusion & curing /Manufacturing of Core (PVC / XLPE)		Y			Y		Y					Y				
	Core Laying								Y								
	Armour wire/strip	Y	Y	Y													
	Inner sheath	Y	Y														
	Armoring		Y							Y							
	Outer Sheathing		Y								Y						
	Finished Cable (IEC-60754 Part-1, IEC 60332-part III cat B/relevant standard)								Y	Y	Y	Y	Y		Y	Y	Y
	Wooden drum (relevant standard) /Steel Drum		Y											Y	Y		
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Make of all major Bought out items will be subject to Owner’s approval.																	
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI BID DOC NO.: CS-6401-001-2					SUB SECTION Q-15- LT POWER & CONTROL CABLE					PAGE 1 OF 3					

CLAUSE NO	QUALITY ASSURANCE		
ROUTINE TESTS	Following routine tests shall be carried out on each drum of finished cables for all types (PVC / XLPE insulated) & sizes.		
1)	Conductor Resistance test		
2)	High voltage test		
ACCEPTANCE TESTS	Following Acceptance tests shall be carried out on each size of each type (PVC / XLPE insulated) of cables, in the offered lot.		
A) For Conductor (as per sampling plan mentioned in IEC Pub 502 (1983)/ BS 6346:1969/ IEC 60502-2 (2005))			
	1)	Annealing test (Copper)	
	2)	Tensile Test (Aluminum)	
	3)	Wrapping Test (Aluminum)	
	4)	Resistance test	
B) For Armour Wires / Formed Wires (If applicable) (as per sampling plan mentioned in IEC Pub 502 (1983)/ BS 6346:1969/ IEC 60502-2 (2005))			
	1.	Measurement of Dimensions	
	2.	Tensile Tests	
	3.	Elongation Test	
	4.	Torsion Test For Round wires only	
	5.	Wrapping Test	
	6.	Resistance Test	
	7.	Mass of Zinc coating test For G S wires / Formed wires only	
	8.	Uniformity of Zinc coating For G S wires / Formed wires only	
	9.	Adhesion test For G S wires / Formed wires only	
	10.	Freedom from surface defects	
C) For PVC / XLPE insulation & PVC Sheath (as per sampling plan mentioned in IEC Pub 502 (1983)/ BS 6346:1969/ IEC 60502-2 (2005))			
	1)	Test for thickness	
	2)	Tensile strength & Elongation before ageing (for tests after ageing see “D”)	
	3)	Hot set test (For XLPE insulation)	
D) Ageing test:			
If the compound manufacturer is carrying out Ageing test, test report of compound manufacturer is to be reviewed. If the compound manufacturer is not carrying out ageing test, then cable manufacturer will carry out ageing test & the test report will be reviewed by owner (quantum of ageing test sample shall be one sample /batch)			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION – VI BID DOC NO.: CS-6401-001-2	SUB SECTION Q-15- LT POWER & CONTROL CABLE	PAGE 2 OF 3

CLAUSE NO	QUALITY ASSURANCE		
E) Following tests will be carried out on completed cables as per relevant standard on each size of each type (PVC / XLPE insulated)			
	1)	Insulation resistance test (Volume resistivity method)	
	2)	High voltage test	
F) Following tests shall be carried out on only one size of offered lot (comprising of all sizes & types)			
	1)	Thermal stability test on PVC insulation and outer sheath	
	2)	Oxygen index test on outer sheath	
	3)	Smoke density rating test on outer sheath	
	4)	Acid gas generation test on outer sheath	
G) Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cables as per following sampling plan:			
		This test will be carried out using composite sampling i.e., irrespective of size; cables of one particular type (i.e., armoured PVC insulated, unarmoured PVC insulated, armoured XLPE insulated, unarmoured XLPE insulated) will be bunched together, as per calculations in line with the IEC. All sizes of PVC & XLPE insulated, armoured & unarmoured cables shall be covered. For one particular type, cables with OD less than or equal to 30 mm shall be clubbed together in touching formation while cables with OD greater than 30 mm shall be clubbed together leaving a gap equal to OD of cable having least diameter. Cable OD shall be taken as nominal overall diameter as per approved datasheet.	
H) Following tests shall be carried on one length of each size of each type (PVC / XLPE insulated) of offered lot:			
	1)	Constructional / dimensional check, surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Sequential marking, drum / Batch (outer sheath extrusion batch) number marking on sheath	
	2)	Measurement of Eccentricity & Ovality	
GENERAL NOTE:			
(a) In case of manufacturers / supplier who have supplied cables in the past through Corporate Centre: - Routine Test of manufacturer internal test reports are to be verified by owner and Main Contractor at the time of final inspection. Owner and Main Contractor will also witness routine tests on cables on 10% sample basis. (b) In case of manufacturers / supplier WHO HAVE NOT SUPPLIED cables in the past through Corporate Centre: - Routine Test of manufacturer internal test reports are to be verified by Owner at the time of final inspection. Owner will witness routine tests on cables for the first order on 10% sample basis and Main Contractor will witness routine tests on cables for the first order on 100% basis.			
1. For Smoke Density rating test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection. 2. For Acid Gas Generation test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection. 3. For Oxygen Index test: if the test result without conditioning is within (+)7% of the minimum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection. 4. In case the test results without conditioning do not meet the maximum/minimum specified value, the manufacturer may exercise the option of retesting the samples after conditioning as per standard.			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION – VI BID DOC NO.: CS-6401-001-2		SUB SECTION Q-15- LT POWER & CONTROL CABLE PAGE 3 OF 3

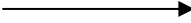

HT SWITCHGEAR													
ITEMS, COMPONENTS, SUB-SYSTEM ASSEMBLY	ATTRIBUTES / CHARACTERISTICS												
	Make, Type, Model, Rating & TC	Electrical Properties	Mechanical properties	Chemical Properties	Dimensions & Finish	Constructional, Functional & Operational Features as per NTPC Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint shade, thickness, adhesion & finish	Functional Checks	HV & IR Test	Degree of Protection Routine test as per NTPC spec.	CB Operation timing check
CRCA steel sheet/ Aluzinc*/ Zinalum*/ Galvalum*	Y		Y	Y	Y		Y						
Aluminum Bus bar material (IS: 5082)	Y	Y	Y	Y	Y		Y						
Copper Bus bar material (IS: 613)	Y	Y	Y	Y	Y		Y						
Bus bar Support Insulator	Y	Y	Y		Y		Y				Y		
HT Circuit Breaker (IEC-62271-100)	Y				Y	Y	Y			Y			Y
HT Contactors (IS: 9046 / IEC 60470)	Y				Y	Y	Y			Y			Y
Protection & Auxiliary Relays	Y				Y	Y	Y			Y			Y
HT CT's & PT's (IS: 2705 / 3156)	Y				Y		Y						Y
HT Fuses (IS: 9385)	Y				Y	Y	Y						
Surge Arrester (IEC: 99 -4)	Y				Y		Y						Y
LT Contactors (IS: 13947)	Y				Y	Y	Y			Y			
Control & Selector Switches (IS: 6875)	Y				Y	Y	Y			Y			
Indicating Meters (IS: 1248)	Y				Y	Y	Y			Y			Y
Indicating Lamps (IS: 13947)	Y				Y	Y	Y			Y			
Push Buttons (IS: 4794)	Y				Y	Y	Y			Y			
Control Transformer (IS: 12021)	Y				Y	Y	Y			Y			Y
LT Fuses (IS: 13703)	Y				Y	Y	Y						
Energy Meters (IS: 722)	Y				Y	Y	Y			Y			Y
Transducers (IEC: 60688)	Y				Y	Y	Y			Y			Y
Diodes	Y	Y				Y	Y			Y			
Terminal Blocks	Y	Y				Y	Y						
Synthetic Rubber Gasket (IS: 11149 / 3400)	Y	Y			Y		Y						
Breaker Handling Trolley	Y				Y	Y			Y	Y			
HT Switchgear Panel IEC-62271-200)	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Make of all major Bought Out Items will be subject to NTPC approval. 3. Temperature rise test reports for diode plates with actual heat sink will be verified.													
* CRCA Galvanized steel with metal coating composed of Al (55%), Zn (43.4%) & Si (1.6%).													

LT SWITCHGEAR

(MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)

ATTRIBUTES / CHARACTERISTICS →														
ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLY ↓	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per NTPC Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per NTPC spec	All Routine tests as per NTPC spec. & IS
Sheet Steel (IS: 513)	Y	Y		Y	Y		Y							
Aluminum Bus bar Material (IS: 5082)	Y	Y	Y	Y	Y		Y							
Copper Bus bar Material (IS: 613)	Y	Y	Y	Y	Y		Y							
Support Insulator	Y	Y	Y	Y			Y							
Air Circuit Breaker (IS: 13947)	Y	Y				Y	Y			Y	Y			Y
Energy Meters (IS: 13010, 13779)	Y	Y				Y	Y			Y				Y
Power & Aux. Contactors (IS : 13947)	Y	Y				Y	Y			Y				
Protection & Aux. Relays (IS : 3231) (IEC 60255 / IEC 61850)	Y	Y				Y	Y			Y				Y
Control & Selector Switches (IS: 13947)	Y	Y				Y	Y			Y				
CT's & PT's (IS 2705 / 3156)	Y	Y					Y							Y
MCCB (IS: 13947)	Y	Y					Y			Y				
Indicating Meters (IS: 1248)	Y	Y				Y	Y			Y				Y
Indicating Lamps (IS: 13947)	Y	Y				Y	Y			Y				
Air Break Switches (IS: 13947)	Y	Y				Y	Y			Y				
Control Terminal Blocks	Y	Y				Y	Y							

LT SWITCHGEAR (MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)

ATTRIBUTES / CHARACTERISTICS 														
ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLY 	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per NTPC Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per NTPC spec	All Routine tests as per NTPC spec. & IS
Fuse (IS 13703)	Y	Y				Y	Y							
Control Transformer (IS: 12021)	Y	Y				Y	Y			Y				Y
Push Buttons (IS: 4794)	Y	Y				Y	Y			Y				
Transducer (IEC: 60688)	Y	Y				Y	Y			Y				Y
MCB (IS: 8828)	Y	Y				Y	Y			Y				
Breaker Handling Trolley	Y	Y				Y			Y	Y				Y
Synthetic Rubber Gasket (IS: 11149)	Y	Y		Y	Y		Y							
LT SWITCHGEAR (IS: 8623)	Y	Y				Y	Y	Y	Y	Y		Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to NTPC approval.

LT BUSDUCT																
ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY	ATTRIBUTES, CHARACTERISTICS	Dimension & Surface Finish	Make, Type, Rating & TC	Electrical Properties	Mechanical Properties	Chemical Properties	Item to conform to relevant IS	WPS Approval, Welder Qualification	Weld Quality Check (DP test & x-ray Test)	Paint Shade, Thickness, Adhesion & Finish	Tightness by Torque measurement	Electrical Clearances	Galvanizing Test as per IS 2629/ 2633/ 4759	IR – HV – IR Test	Phase Sequence Check	Degree of Protection routine test as per NTPC spec.
Aluminum Sheets / Plates / Strips / Flexibles / tubes (IS: 5082 / 737)		Y	Y		Y	Y	Y	Y								
CRCA Flats / ISMC (IS 2062)		Y	Y		Y	Y	Y									
Neoprene / Synthetic Rubber Gaskets (IS 11149 / 3400)		Y	Y		Y	Y										
Rubber Bellows (IS: 3400)		Y	Y		Y	Y										
Support Insulator (BS: 2782, IEC: 660, IS: 10912)		Y	Y	Y	Y											
Galvanized Structure & GI Earthing Flat (IS: 2629 / 2633 / 4749)		Y	Y				Y						Y			
Space Heater & Thermostat			Y	Y										Y		
LT Busduct (IS: 8623 PART 2)		Y	Y				Y	Y	Y	Y	Y	Y		Y	Y	Y
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Makes of all major Bought Out Items will be subject to NTPC approval.																

Medium Voltage BUS DUCT											
ATTRIBUTES / CHARACTERISTICS ITEMS/COMPONENTS SUB SYSTEMS	Visual & Dimensional Checks	Electrical / Mechanical / Chemical Properties	WPS & PQR	NDT (RT / DP / MPI / UT)	Painting Quality & Adhesion Test	Galvanizing Test as per IS: 2629 / 2633 / 6745	Electrical clearance & Creepage distance	Functional/Operational check	Make / Type Rating / Model / TC / Embossing/Printing of make & batch /General Physical Inspection	Trial Assembly at works.	Routine Test as per relevant standard / NTPC Specification
Enclosure / Cubicle	Y	Y		Y	Y		Y				Y
Bus bar Conductor / Flexible Connector & Dis-connector Link	Y	Y		Y							
Galvanized Steel Structure & Plate (Steel as per IS:2062)	Y					Y					
Epoxy / Seal-off Bushing & Epoxy / Porcelain Post / Support Insulator	Y	Y					Y		Y		Y
Welding of enclosure & conductor	Y		Y	Y							
Gasket, Silica gel Breather, Elastomer Spring Head		Y						Y	Y		
Complete Bus Duct & Cubicles IS:8084	Y				Y		Y			Y	Y
Note: 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2) All major Bought Out Items will be subject to NTPC approval.											

VFD MODULE				
ATTRIBUTES / CHARACTERISTICS ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Visual & Dimen sional checks	Make / Type / Rating etc.	Final Inspection as IS / IEC	Remarks
HT Breaker (IEC 56)	Y	Y	Y	
DC Reactor	Y	Y		For details refer table for DC Reactor
Transformer	Y	Y		For details refer table for Transformer
Motor	Y	Y		For details refer separate table for Motor
VFD Panel	Y	Y		For details refer table for VFD
<p>Note:</p> <p>1) This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization.</p> <p>2) Make of all major Bought Out Items will be subject to NTPC approval.</p>				

DC REACTOR								
ATTRIBUTES / CHARACTERISTICS								
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Visual	Dimensional	Mech. & Chem. Property	Electrical Characteristics	Pretreatment by Seven Tank	Painting by Stove Enameling	Final Inspection as per IS-2026	Welding/NDT
Winding Material (Aluminium)	Y	Y	Y	Y				
Insulation Material	Y	Y		Y				
Sheet Steel	Y	Y	Y					
Winding	Y	Y		Y				
Fabrication of Enclosures	Y	Y			Y	Y		Y
Assembly	Y	Y						
Routine Tests	Y	Y					Y	
<p>Note:</p> <p>1) This is an indicative list of tests/checks. The manufacturer to furnish a detailed Quality Plan indicating their practice & procedure along with relevant supporting documents during QP finalization for all items.</p> <p>2) All major Bought Out Items will be subject to NTPC approval.</p>								

DRY TYPE TRANSFORMER												
ATTRIBUTES / CHARACTERISTICS												
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model / TC / General Physical Inspection	WPS & PQR	Routine Test as per relevant standard	Measurement of capacitance & tan delta between winding	Routine Test
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y						Y				
Copper Conductor	Y	Y	Y		Y							
Insulating Material	Y			Y	Y							
CRGO Lamination & Built Core	Y											
Bushing /Insulator (IS:2544 / 5621)	Y							Y		Y		
Gasket	Y							Y		Y		
Off-Circuit Tap Changer	Y							Y				
Core Coil Assembly	Y						Y					
Marshalling Box	Y									Y		
WTI, Thermistor, Terminal Connector	Y							Y				
Welding									Y			
Complete Transformer (IS:11171 / IEC 60076)	Y										Y	Y
Notes: 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalization for all items. 2) All major Bought out Items will be subject to NTPC approval.												

VFD PANEL														
ATTRIBUTES / CHARACTERISTICS														
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Electrical Properties	Mechanical Properties	Chemical Properties	Dimensions / Finish	Type/ Rating/Functional check	HV/IR	Routine test as per relevant std.	Constructional Features	IS:6005, Seven tank process	Paint finish/ shade/thickness	Mountings / BOM/ Make, Completeness / Wiring	Interlock Functional & Operation Testing / Simulation check	Degree of Protection Test	Final testing as per Relevant IS/IEC
Sheet Steel (IS-513)		Y	Y	Y										
Aluminum / Copper Bus-bar (IS-5082/IS-613/IS-1987)	Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)	Y	Y	Y	Y										
Control / Selector Switch (IS-6875)					Y	Y	Y							
Contactors/ MCB(IS-13947)					Y	Y	Y							
O/L Protection relays (IS-3231)					Y		Y							
C.T /V.T/ Indicating Meter(IS-2705/3156/1248)					Y	Y	Y							
Fuse/ Fuse carrier (IS-13703)					Y	Y	Y							
Terminals/lugs/PVC wires(IS-13947//IS-694)	Y			Y	Y	Y	Y							
Timers (IS-3231)					Y	Y	Y							
Push Button/ Lamp/ (IS-6875)					Y	Y	Y							
Control Transformer (IS-12021)					Y	Y	Y							
Mimic, Annunciator					Y		Y							
GASKET(IS-11149)		Y	Y	Y	Y		Y							
Fabrication								Y						
Pretreatment & Painting									Y	Y				
VFD panel										Y	Y	Y	Y	Y
NOTE: 1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. All major Bought Out Items will be subject to NTPC approval.														

TRANSFORMER (OIL FILLED)

ATTRIBUTES/ CHARACTERISTICS	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	WPS & PQR	Routine Test as per relevant test	Routine Test
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY													
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y					Y						
Conservator / Radiator / Cooler / Pipes	Y	Y					Y						
Copper Conductor (IS:191)	Y	Y	Y		Y								
Insulating Material	Y	Y	Y	Y	Y	Y							
CRGO Lamination & Built Core	Y	Y	Y		Y	Y							
Bushing / Insulator (IS:2544 / 5621)	Y	Y								Y		Y	
Gasket	Y				Y	Y		Y				Y	
Transformer Oil (IS:335 / IEC296)												Y	
Off-Circuit Tap Changer	Y									Y			
Core Coil Assembly & Pre-tanking	Y								Y				
Marshalling Box	Y	Y					Y					Y	
WTI, OTI, MOG, PRD, Breather, Terminal Connector, Bucholz Relay, Globe & Gate Valve,	Y									Y			
Welding (ASME Sect-IX)	Y										Y		
Complete Transformer (IS:2026/ IEC-60076)	Y												Y

Note:

- 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
- 2) All major Bought Out Items will be subject to NTPC approval.

SWITCHYARD

ATTRIBUTES/ CHARACTERISTICS			
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Make, model, Type & Rating, Test Certificate	Routine & Acceptance Test as per IS / IEC	Functional requirements as per NTPC Specification
765 kV GIS (IEC:62271-203)	Y	Y	Y
400 kV GIS (IEC:62271-203)	Y	Y	Y
220 kV GIS (IEC:62271-203)	Y	Y	Y
132 kV GIS (IEC:62271-203)	Y	Y	Y
Circuit Breaker (IEC:62271-100)	Y	Y	Y
Isolator (IEC:62271-102)	Y	Y	Y
Current Transformer (IEC:60044/BS:3938/IS2705/ IEC: 61869)	Y	Y	Y
Capacitor Voltage Transformer (IEC:186A / 358/IS3156/IEC60044/ IEC: 61869)	Y	Y	Y
Potential transformer (IEC 60044 / IS3156)			
Surge Arrestor (AIS) (IEC:99- 4/IS:3070)	Y	Y	Y
Wave Trap (IEC:353 / IS:8792 / 8793)	Y	Y	Y
Sub Station Automation system (IEC 61850)	Y	Y	Y
Protection Relays	Y	Y	Y
Energy meter	Y	Y	Y
Bus Post Insulator (IEC:168 / 815 / IS:2544)	Y	Y	Y
Disc, Pin & String Insulator (IEC:383 / IS:731)	Y	Y	Y
Aluminum Tube (IS:5082 / 2673 / 2678)	Y	Y	Y
Conductor (IS:398)	Y	Y	Y
Hardware fittings for Insulator (IS:2486 / BS:3288)	Y	Y	Y
Hollow insulator (IEC:233/ IS:5621)	Y	Y	Y
Spacers, Clamps & Connector (IS:10162 / 5561/ 617)	Y	Y	Y
Galvanized Steel Structures (IS:2062/2629/4759/6745)	Y	Y	Y
Vibration Damper (IS:9708)	Y	Y	Y

ATTRIBUTES/ CHARACTERISTICS			
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Make, Type Rating, and Model, Test Certificates	Routine & Acceptance Test as per relevant IS/IEC	Functional requirements as per NTPC Specification
Sag Compensating Spring DIN:2089/2096 IS:3195 / 7906	Y	Y	Y
Long rod Insulator	Y	Y	Y
SF6 Gas filling & evacuating plant	Y	Y	Y
SF6 Gas Leak Detector	Y	Y	Y
Leakage Current Analyzer	Y	Y	Y
Nitrogen Gas Filling Device	Y	Y	Y
Event Logger	Y	Y	Y
Operation Analyzer	Y	Y	Y
Disturbance Recorder	Y	Y	Y
Synchronizing Trolley	Y	Y	Y
Relay Test Kit	Y	Y	Y
<p>Notes:</p> <p>1) This is an indicative list of test/checks. The manufacture is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalization for all items.</p> <p>2) All major Bought Out Items will be subject to NTPC approval.</p>			

MEASURING INSTRUMENTS

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Item Components Sub System Assembly	Attributes Characteristics								
	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (As applicable)(R)	Hydro Test(R)	Material Test certificate ®
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y				
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y				
3. Pr./D.P.Switch(BS-6134)	Y	Y	Y	Y	Y	Y			
4. Electronic Transmitter(IEC-60770)	Y	Y	Y	Y	Y	Y			
5. Temp. Switch	Y	Y	Y	Y	Y	Y			
6. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y			
7. Transducer (IS-14570)	Y	Y	Y	Y	Y	Y			
8. Thermocouples (IEC – 584 / ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y			
9. RTD(IS-2848)	Y	Y	Y	Y	Y	Y			
10. Thermowell	Y		Y				Y	Y	Y
R-Routine Test A- Acceptance Test Y – Test applicable									
Note: 1) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.									

MEASURING INSTRUMENTS

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Item Components Sub System Assembly	Attributes Characteristics												
	GA, Dimensions, Paint Thickness (R)	Make, Model, Type, Rating ,BOM(R)	Process / Electrical connection (R)	Calibration/Functional (R)	Requirement as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Calculation for accuracy (R)	HV/ IR Test (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)	Integral Testing of complete
11. Orifice plate(BS-1042)	Y	Y	Y	Y*	Y	Y**	Y**			Y	Y**	Y	
12. Flow nozzle(BS-1042)	Y	Y	Y	Y*	Y	Y	Y			Y	Y	Y	
13. Impact head type element	Y	Y	Y					Y				Y	
14. Electronics Water Level Indicator (EWLI)	Y	Y	Y		Y		Y		Y	Y	Y	Y	Y
15. Flue Gas & Ambient Air Analysers	Y	Y	Y	Y					Y				Y
16- SWAS System with Analyser & Chiller#	Y	Y	Y	Y			Y		Y	Y	Y	Y	Y
17- Dust emission monitors	Y	Y	Y	Y									
18- Containerised Room	Y	Y	Y						Y			Y	
R-Routine Test A- Acceptance Test Y – Test applicable													
*Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.													
** As applicable													
#Vaccuminasation test of chiller assembly													
Note: 1) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.													

CLAUSE NO.	QUALITY ASSURANCE															<div>एनडीपीसी NTPC</div>		
	INSTRUMENTATION CABLE																	
	TESTS ITEMS		Conductor Resistance ® & (A)	High Voltage ® & (A)	Insulation Resistance ® & (A)	Constructional detail, dimensions (A)	Outer-Sheathe/core marking, end sealing (A)	Thermal Stability (A) +	Visual, Surface finish (A) +	Electrical Parameters ** (A) +	Persulphate Test (A) +	Overall/Coverage/Continuity (A)	Swidesh chimney Test (SS-4241475) (A) ++	FRLS Test * (A) ++	Tensile & Elongation before & after aging (A) ++	Vol. Resistivity. at room & Elevated Temp. (A) ++	Spark test report review ®	
	1. Instrument cable twisted and shielded																	
	Conductor(IS-8130)		Y			Y			Y									
	Insulation(VDE-207)					Y	Y	Y	Y						Y		Y	
	Pairing/Twisting					Y	Y		Y									
	Shielding					Y			Y			Y						
	Drain wire		Y			Y			Y		Y	Y						
	Inner Sheath					Y	Y	Y	Y					Y	Y			
	Outer Sheath					Y	Y	Y	Y					Y	Y			
	Over all cable		Y	Y	Y	Y	Y		Y	Y			Y			Y		
	Cable Drums(IS-10418)					Y			Y									
	<p>Note : High Temp. cables shall be subjected to tests as per VDE-207(Part-6) Compensating cables shall be checked for Thermal EMF/Endurance test as per IS 8784.</p> <p>Note : This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalization for all items.</p> <p>Note : ® - Routine Test A - Acceptance Test Y - Test Applicable</p> <p>Note : Sampling Plan for Acceptance test shall be as per IS 8784 (As applicable)</p> <ul style="list-style-type: none">* FRLS Tests: Oxygen / Temp Index (ASTM D-2863), Smoke Density Rating (ASTM – D 2843), HCL Emission (IEC-754-1)** Characteristic Impedance, Attenuation, Mutual Capacitance, Cross Talk (As applicable) <p>+ Sample size will be One No. of each size/type per lot.</p> <p>++ Sample size will be One No. sample for complete lot offered irrespective of size/type.</p>																	
	GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE			TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2						SUB-SECTION-Q-21 INSTRUMENT CABLE				PAGE 1 OF 1				

CLAUSE NO.	QUALITY ASSURANCE																					
	POWER SUPPLY FOR C&I SYSTEMS (UPS/BATTERY/BATTERY CHARGER/ACDB/DCDB)																					
	ITEMS		TESTS																			
			Visual/dimension/rating/ Paint Adhesion/ Thickness (R)		General arrangement/BOM/make of components /Mimic ®																	
			Efficiency regulation(R)		Input voltage variation (A)																	
			Out put voltage and frequency adj. range(A)		Preliminary light load test(R)																	
			Load transfer retransfer test (R) *		AC input failure and return test (R)																	
			Parallel operation and current division(R)		Relative harmonic content(R)																	
			Restart with PRI A.C and battery (separately)(R)		System transfer and retransfer (R) *																	
			Asynchronous transfer(R)		Ripple content(R)																	
			Load limiter operation (R)		IR/HV/R)																	
			Tests as per standard & specification (R)&(A)																			

CLAUSE NO.	QUALITY ASSURANCE													<div>एनडीपीसी NTPC</div>
	ELECTRICAL ACTUATOR WITH INTEGRAL STARTER													
	Test/Attributes Characteristics ITEM/ COPONENT/ SUB SYSTEM ASSEMBLY/ TESTING	RPM ®	No Load Current ®	IR & HV Test®	Mounting Dimension®	All routine Test as per Standard & Specification®	Correct Phase Sequence®	Operation & Setting of limit Switch/Torque Switch®	Stall Torque/Current (A)	Hand Wheel operation/ Auto de clutch function (A)	Function of Aux. like Potentiometer, space heater, position indicator ®	EPT output ®	Local/ Remote (Open-Stop-Close) Operation®	Safety check (Single phasing, Phase correction, Tripping etc.) (A)
	ELECTRICAL ACTUATOR with Integral Starter , Non- Intrusive Electrical Actuator (EN15714-2)													
	Motor	Y	Y	Y	Y	Y								
	Final Testing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	Note: 1) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the practices and procedure adopted along with relevant supporting documents. - SIL 2 certificate if applicable ® - Routine Test (A) - Acceptance Test Y - Test applicable													
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE				TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC. NO.: CS-6401-001-2				SUB-SECTION-Q-24 Electrical Actuator with Integral Starter				PAGE 1 OF 1		

	<div>VMS & TSI System</div> <table><tr><td><div>TEST/ATRIBUTES CHARACTERISTICS</div><div>ITEM</div></td><td>Linearity(R)</td><td>Frequency Response(R)</td><td>Calibration with simulated output. (R)</td><td>Spectrum(Harmonic Analysis (A)</td><td>Predictive Analysis Functions (A)</td><td>Storage & Comparative analysis of vibration(A)</td><td>Generation/analysis of plots (A)</td><td>Simulation test & generation of operator guidance (A)</td></tr><tr><td>TURBO SUPERVISORY/ VIBRATION MONITORING SYSTEM</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Proximeter</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Acclerometer</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>LVDT</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Monitor</td><td>Y</td><td></td><td>Y*</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Overall System</td><td></td><td></td><td></td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr><tr><td colspan="3">R-Routine Test Test applicable</td><td colspan="4">A- Acceptance Test</td><td colspan="2">Y –</td></tr><tr><td colspan="9">Note: 1) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supplying documents. * applicable for monitor electronics</td></tr></table>									<div>TEST/ATRIBUTES CHARACTERISTICS</div> <div>ITEM</div>	Linearity(R)	Frequency Response(R)	Calibration with simulated output. (R)	Spectrum(Harmonic Analysis (A)	Predictive Analysis Functions (A)	Storage & Comparative analysis of vibration(A)	Generation/analysis of plots (A)	Simulation test & generation of operator guidance (A)	TURBO SUPERVISORY/ VIBRATION MONITORING SYSTEM									Proximeter	Y	Y							Acclerometer	Y	Y							LVDT	Y								Monitor	Y		Y*						Overall System				Y	Y	Y	Y	Y	R-Routine Test Test applicable			A- Acceptance Test				Y –		Note: 1) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supplying documents. * applicable for monitor electronics								
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CLAUSE NO.	QUALITY ASSURANCE								<div>एनटीपीसी NTPC</div>																																																																																																																													
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GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE			TECHNICAL SPECIFICATIONS SECTION VI, PART- B BID DOC. NO.: CS-6401-001-2			Sub Section Q-26 Survelliance & Communication System, PLC, Fire ,LVS & Control Desk		PAGE 1 OF 1																																																																																																																														

CLAUSE NO.	QUALITY ASSURANCE		
	<div>DDCMIS</div>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2	SUB-SECTION-Q-27 DDCMIS	PAGE 1 OF 8

CLAUSE NO.	QUALITY ASSURANCE																		
1.00.00 1.01.00	REQUIREMENTS OF AUTHORISATION-TO-SHIP-TEST (ATST) FOR DDCMIS																		
	(a) Authorization-to-ship-test (ATST) or Factory Acceptance Test (FAT) (both terms have been used interchangeably) shall include all required tests to fully demonstrate to Employer’s satisfaction that each equipment/sub-system/system as well as software modules furnished as per this specification as well as DDCMIS as a whole, fully meets the functional, parametric and other requirements of this specification and Employer’s approved drawings/documents under all operating regimes. The procedure defined here is applicable for one DDCMIS system. Number of DDCMIS systems and their sub-systems shall be as defined in Part-A of technical specifications.																		
	(b) Contractor to note that ATST / FAT procedure given below in subsequent clauses are only indicative in order to help the Contractor in understanding the requirements and help him in submitting a detailed procedure based on these guidelines meeting all the specification requirements.																		
	(c) The results of the following activities shall be made available to the Employer’s representative before start of ATST / FAT.																		
	(i) Compliance check for Major Design Feature (including Customization if any), as per Part-C, GTR or agreements regarding this.																		
	(ii) Implementation check of various applications including those based on NTPC input, as per Part-C, GTR or agreements regarding this.																		
	(d) Generally, the ATST / FAT shall be carried out with the equipment earmarked for the particular project and unit. However, for the following item, the testing can be carried out with similar / equivalent dummy equipment fulfilling the following condition, subject to Employer’s approval.																		
	<table><tr><th>SN</th><th>ITEM</th><th>CONDITION</th></tr><tr><td>1</td><td>LVS</td><td>Testing of LVS functionalities can be done by using monitors connected to the LVS Workstations. Dispatch of LVS can be allowed like a cat-III item, but only after successful testing of functionalities as indicated above.</td></tr><tr><td>2</td><td>LVS WS / OWS</td><td>LVS WS / OWS for the first unit to be tested on the target machines. In case the testing carries over to next unit, dummy equipment may be used. Dispatch of LVS WS / OWS of subsequent units can be allowed like a cat-III item, but only after successful testing of first unit as indicated above.</td></tr><tr><td>3</td><td>MASTER CLOCK</td><td>Can be directly dispatched if alternate test set-up for time synchronization can be arranged.</td></tr><tr><td>4</td><td>NETWORK COMPONENT</td><td>To be done with target machines only for first unit. In case the testing carries over to next unit, dummy equipment may be used. Dispatch of network components of subsequent units / station can be</td></tr></table>				SN	ITEM	CONDITION	1	LVS	Testing of LVS functionalities can be done by using monitors connected to the LVS Workstations. Dispatch of LVS can be allowed like a cat-III item, but only after successful testing of functionalities as indicated above.	2	LVS WS / OWS	LVS WS / OWS for the first unit to be tested on the target machines. In case the testing carries over to next unit, dummy equipment may be used. Dispatch of LVS WS / OWS of subsequent units can be allowed like a cat-III item, but only after successful testing of first unit as indicated above.	3	MASTER CLOCK	Can be directly dispatched if alternate test set-up for time synchronization can be arranged.	4	NETWORK COMPONENT	To be done with target machines only for first unit. In case the testing carries over to next unit, dummy equipment may be used. Dispatch of network components of subsequent units / station can be
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GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2	SUB-SECTION-Q-27 DDCMIS	PAGE 2 OF 8															

CLAUSE NO.	QUALITY ASSURANCE			
1.01.01			allowed like a cat-III item, but only after successful testing of functionalities as indicated above.	
	5	VARIOUS BUS SYSTEM CABLES	For FAT, the target Main system bus shall be used. In case the testing carries over to next unit, dummy equipment may be used.	
1.01.02	The Authorization-To-Ship-Test (ATST) shall include all reasonable exercises which the combination of equipment and software can be expected to perform. These tests shall be divided into, as a minimum, but not limited to the following categories:			
	(a)	Hardware tests		
	(b)	Functional tests		
	(c)	Parametric test		
	All reference documents like all approved drawings / documents, NTPC specifications, DDCMIS system manuals, etc. shall be available at the start of ATST. The Quality Assurance related tests shall be as per approved QP (Quality Plan) for DDCMIS. The ATST tests are briefly described in subsequent clauses.			
	Hardware tests			
	These tests shall include but not be limited to the following tests. These tests will be conducted on full population on sample basis as finalized during ATST procedure finalization and NTPC engineer’s decision during ATST.			
	(a.) Verification of healthiness of all types of modules e.g., I/O modules, controller modules, processors, peripherals, etc. on a sample basis.			
	(b.) System configuration:			
	(1.) Verification of system configuration with reference to approved configuration diagrams including verification of controller configuration, group / sub-group segregation; grouping of controllers, I/O redundancy, verification of multiple measurement scheme, HMIPIS configuration, etc.			
	(2.) Verification of major features of complete DDCMIS like on line removal of I/O and controller modules, etc. in line with specification requirements.			
	(3.) Verification of spare capacity for example spare channels, spare wired-in space in cabinets/ cubicles, terminal blocks, peripherals, etc. as per approved documents.			
	(c.) Simulation of inputs / Outputs			
	System shall have feature to simulate/ forcing I/Os on OWS / LVS OWS. Additionally hardware simulation of I/Os shall be available for specific applications like fail safe system.			
	(d.) Accuracy test:			
	System accuracy for each type of analog input shall be demonstrated on sample basis, if this test is not carried out in MDFT.			
	(e.) Demonstration of the manual and auto switchover from master to standby system bus, controllers, I/Os, processors etc.			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2	SUB-SECTION-Q-27 DDCMIS	PAGE 3 OF 8

CLAUSE NO.	QUALITY ASSURANCE			
1.01.03	(f.)	Loop reaction time shall be demonstrated for loops / logics / functions applicable as per specification and ATST procedure.		
	(g)	SOE function shall be tested as follows, where the same is applicable (refer Part-A of specifications). For SER function, verification of resolution of SOE inputs, time synchronization with master clock, data base modification, SOE report, printout, other features etc. For this purpose a test-simulator to generate sequences of 1 ms resolution for 50 points (or as agreed during finalization of ATST procedure) distributed in different panels shall be made available during testing.		
	(h)	Power supply: Testing of power supply system to DDCMIS, tolerance of DDCMIS w.r.t. voltage & frequency limits as specified, performance of DDCMIS with power supply break as specified .(One sample of each type)		
	(i)	Diagnostics Tests : On – line diagnostic tests on HMIPIS, individual peripherals, Control System, programmer stations, etc.		
	Functional Tests			
	The following tests shall be carried out on Contractor’s DDCMIS.			
	(a.)	Functional tests of CLCS:		
	(1.)	Verification of proper signal acquisition, conditioning and distribution, 2 transmitters / 3 transmitter selection.		
	(2.)	Verification of proper realization of controller functions like bump less transfer from auto to manual and vice versa, functional checking of bias circuit (wherever provided), etc.		
	(3.)	Verification of response of control system by simulating changes in the system inputs in line with the approved ATST procedure.		
(4.)	Verification of signal exchange between FGs and from other systems (if applicable)			
(b.)	Functional tests of OLCS:			
(1.)	Verification of proper signal acquisition, conditioning and distribution, 1v2, 2v3 implementation.			
(2.)	Verification of proper realization of logic functions, sequence control functions, running of complete start up program sequence in all modes of operation, shut down program, etc.			
(3.)	Verification of logic computation in controller by simulating inputs.			
(4.)	Verification of signal exchange between FGs and from other systems (if applicable)			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2	SUB-SECTION-Q-27 DDCMIS	PAGE 4 OF 8

CLAUSE NO.	QUALITY ASSURANCE		
	<p>(c.) Functional tests for HMIPIS</p> <ol style="list-style-type: none"> (1.) Verification of all types of displays, logs including their formats, bar graphs, X-Y plots etc. availability of all operator functions. (2.) Verification of event generation and handling capabilities of HMIPIS processors by simulating various types of events/data and observing associated event sequence display and alarms.. (3.) Calculations: All calculations shall be tested on sample basis to demonstrate that these are in accordance with the specification and Employer's inputs as applicable. The Contractor shall prepare all tests cases for calculations for proper verification for the features required for each type of computations. (4.) Checking historical storage and retrieval functions including long term storage. (5.) Testing of initialization and loading of configuration data, etc. (6.) Verification of all programmer's stations functions for HMIPIS and Control System, as well as for documentation facility as specified. (7.) Testing of each peripheral viz., monitors, printers, optical disks, hard disk drive, etc. (8.) Testing of time synchronization function of system time of DDCMIS (Control System, HMIPIS & Systems on LAN). In case it is not possible to bring the master clock procured under this package, then signal generator with stable source, capable of generating all required type of synchronizing signal to be arranged by Contractor. (9.) Testing of the Station LAN shall be carried out with unit DDCMIS (with panels), standalone DDCMIS (with panels or software simulation), Switchgear DDCMIS and at least one (1) other DDCMIS system (with panels or software simulation), as well as two client PC's, one third party PLC and Numerical relay system (if applicable). Bidder shall arrange a PC with OPC server (excluded from his scope of supply) which shall be used by the Bidder to simulate signal exchange between Bidder's Station LAN and third party PLC during the testing of Station LAN, at Bidder's works . During the testing of Station LAN as mentioned above complete switchgear DDCMIS (with panels) shall be connected. Numerical Relay & Ethernet Switch Vendor will arrange a prototype ring with at least three Ethernet switches (L2) with one IED of each type and L3 Switches network, at the works of the DDCMIS supplier along with the necessary engineering support. Exact test setup shall be finalized during detailed engineering. (10.) Unified HMIPIS: Testing of Unified HMIPIS functionality as per respective approved documents. <p>(d.) Security Audit (as applicable)</p> <ol style="list-style-type: none"> (1.) For checking compliance to the security policies & procedures in Station LAN/HMI of all DDCMIS and Switchgear Relay network integrated to the 		
<p>GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2</p>	<p>SUB-SECTION-Q-27 DDCMIS</p>	<p>PAGE 5 OF 8</p>

CLAUSE NO.	QUALITY ASSURANCE		
<p>1.01.04</p>	<p>Switchgear DDCMIS, security audit by a certified auditor (as per CERT- IN panel) is to be arranged by the Contractor during ATST. The security audit for Switchgear Relay network integrated to the Switchgear DDCMIS shall be done on prototype ring and hardware arranged by the vendor during Station LAN FAT. This shall include vulnerability assessment of the workstations/ servers and penetration testing of the Station LAN through the firewall from a node outside the network. Suitable actions based on the findings of the security audit shall be carried out by the Contractor.</p> <p>Parametric tests</p> <p>Following tests shall be carried out to test Contractor's DDCMIS w.r.t. specification requirements.</p> <ul style="list-style-type: none"> (a.) For control system (CLCS+OLCS): <ul style="list-style-type: none"> (1.) CPU loading (2.) Cycle time/controller reaction time. (3.) Memory spare capacity (b.) For MMIPIS <ul style="list-style-type: none"> (1.) CPU loading (2.) Spare duty cycle (3.) Spare memory capacity (c.) Spare duty cycle for system bus (d.) Various display & command response time (e.) System accuracy (if not carried out in MDFT) (f.) Display update time on OWS LVS <p>Parametric tests of Unified HMIPIS for complete Unit DDCMIS shall also be carried out, if specified in Part-A of specifications.</p> <p>1.02.00 Integrated Test Set-Up</p> <p>For integrated testing of the total DDCMIS system, the Contractor shall employ a test set-up, which will be capable of generating I/O signals in a requisite manner. It is preferable to adopt soft signal simulating device to avoid / minimise the cumbersome process of physical connection of I/Os through potentiometers, switches, Lamps / LEDs etc. The exact configuration / set-up shall be as finalized during detailed engineering.</p> <p>1.02.01</p> <p>The Contractor is to submit Authorisation-To-Ship-Test (ATST) procedure and requirements of above and other applicable clauses of this specification. Since, the exact definition & extent / parameters of ATST can be finalized only when the engineering of DDCMIS has been finalized to a great extent, it is required that the detailed draft ATST procedure be submitted by the Contractor at a later date as intimated by the Employer during engineering stage for Employer's comment and finalization. Contractor shall incorporate all modifications, additions/ deletions to the ATST procedure as indicated by the Employer. The ATST shall be conducted as per Employer approved procedure for ATST. The Employer reserves the right to ask the</p>		
<p>GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2</p>	<p>SUB-SECTION-Q-27 DDCMIS</p>	<p>PAGE 6 OF 8</p>


CLAUSE NO.	QUALITY ASSURANCE			
	<p>Contractor to conduct any other test not covered in ATST procedure also during the ATST which may be required to fully satisfy the Employer regarding full compliance with specification requirements. Contractor shall conduct all such tests also within the quoted lump sum price for this contract.</p>			
1.02.02	<p>The results of all ATS Tests shall be properly documented by the Contractor and submitted to Employer along with all annexures.</p>			
1.02.03	<p>Following the tests, if in the opinion of the Employer, the system has not been adequately manufactured, programmed, tested or debugged the Contractor shall make good all deficiencies, and re-run the test to fully satisfy the Employer regarding full compliance with specification requirements and requisite quality standards.</p>			
1.02.04	<p>The system shall not be shipped without approval of Employer in writing.</p>			
1.02.05	<p>Upon successful completion of Authorization-To-Ship Test, the Employer will provide the Contractor with a written authorization for shipment of the system equipment to the project site.</p>			
1.02.06	<p>All final documentation as per requirement of this specification shall be available at the time of Authorization-To-Ship-Test and this shall be dispatched along with the equipment in required number of copies.</p>			
1.02.07	<p>Contractor shall note that no payments towards dispatch of equipment and subsequent activities shall be due and payable to the Contractor till the Contractor is able to successfully demonstrate to Employer's satisfaction that the DDCMIS and parts thereof fully meet the Authorization-To-Ship Test requirements.</p>			
1.02.08	<p>The ATST or FAT of DDCMIS shall be conducted at the employer approved works of the DDCMIS supplier or DDCMIS Supplier's Associate. Further DDCMIS shall be supplied from the same works.</p>			
2.00.00	<p>The ATST requirements as indicated above shall form an integral part of QAP (Quality Assurance Plan) of DDCMIS system(s) envisaged for the package/project. Over and above the tests and requirement indicated above, the QP for DDCMIS system shall be submitted to employer for approval. The QAP envisaged for the offered DDCMIS system for employer shall also include testing of following attributes of the offered system by Employer.</p>			
2.01.00	<p>The tests indicated in the following QA tables are indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents, if desired by employer.</p>			
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2		SUB-SECTION-Q-27 DDCMIS
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CLAUSE NO.	QUALITY ASSURANCE										
	DISTRIBUTED DIGITAL CONTROL MONITORING & INFORMATION SYSTEM (DDCMIS)										
	<div>TESTS</div> <div>ITEMS</div>										
		Pre Power on Check (#) (R)									
		Post Power on Check (%) (R)									
		Internal cabling / Wiring checking(R)									
	Door Alignment, waviness, and Locking (R)										
	Louvers, Fans, wire mesh, Lifting arrangement (R)										
	HV / IR on wired panels (R)										
	Paint Shade, Thickness and Illumination (R)										
	Hardware/Make as per BOM (R)										
Dimensions, GA, layout (R)											
Environmental Stress Screening test (R).											
DDCMIS											
DDCMIS CUBICLES	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
OWS and Peripherals								Y			
R-Routine Test		A- Acceptance Test				Y – Test applicable					
<p>Note: 1) These test are minimum requirement and necessary covered in Manufacturing Quality Plan and manufacturer is also need to include their practices and Procedure in MQP along with relevant supporting documents.</p> <p># Pre power on check: - Wire dressing, looseness, Availability of Fuses and MCB, Modules are inserted properly, Earthing connection, Input Voltage checking, Availability of resistance matt near panels, Availability of Electro Static Discharge measure for electronics components.</p> <p>% Post Power On Check: - Current & power consumption of DDCMIS Cabinets, I/O check as per signal flow.</p>											
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE				TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2				SUB-SECTION-Q-27 DDCMIS		PAGE 8 OF 8	

ITEMS

ITEMS	TESTS													
	Visual & Dimensions ®	GA, BOM, Layout of component & construction feature, Paint Shade/thickness ®	Flattening,flaring,hydrotest,hardness check as per ASTM standard (A)	Component Ratings ®	Wiring ®	Make, Model, Type, Rating®	IR & HV ®	Review of TC for instrument/devices (R)	Accessibility of TBs/Devices Illumination,grounding ®	Tubing ®	Leak/Hydro test(A)	Chemical/physical properties of material (A)	Proof pressure test,Dismantling & reassembly test,Hydraulic impulse and vibration test (R)	Tests as per standards & specification
Local Instrument enclosure	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			
Local instruments racks	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			
Junction Box	Y	Y*		Y		Y	Y							
Gauge Board	Y	Y		Y		Y		Y		Y	Y			
Impulse pipes and tubes	Y		Y			Y						Y		
Socket weld fittings ANSI B-16.11	Y					Y						Y		Y
Compression fittings	Y					Y					Y	Y	Y	
Instrument valves & Valve manifolds	Y					Y					Y	Y		
Copper tubings ASTM B75	Y					Y								Y

Note: This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

CLAUSE NO.	TECHNICAL SPECIFICATIONS 		
	<p style="text-align: center;">QUALITY ASSURANCE FOR CIVIL WORKS</p> <p>1. GENERAL QA REQUIREMENTS</p> <p>The contractor shall ensure that the works, BOIs and services under the scope of contract whether manufactured or performed within contractor's works or at his sub-contractor's premises or at the NTPC's site or at any other place of work are in accordance with the NTPC technical specification, applicable standards / codes, approved drawings / data sheets / and BOQ.</p> <p>2. SAMPLING AND TESTING OF CONSTRUCTION MATERIALS</p> <p>The method of sampling for testing of construction materials and work / job samples shall be as per the relevant IS / standards / codes and in line with the requirements of the technical specifications.</p> <p>The contractor shall carry out testing in accordance with the relevant IS / standards / codes and in line with the requirements of the technical specifications / quality plans. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer in Charge (EIC). All testing shall be done in a site lab. / NTPC acceptable third-party Laboratory.</p> <p>3. FIELD QUALITY PLAN</p> <p>Well before the start of the work, the contractor shall prepare and submit the Field Quality Plans (FQP) on the format No. QS-01-QAI-P-03/F2, and obtain approval of NTPC, which shall detail out for all the works, equipment's, services, quality practices and procedures etc. in line with the requirement of the technical specifications to be followed by the contractor at site. This FQP shall cover for all the items / activities covered in the contract / schedule of items required, right from material procurement to completion of the work at site.</p>		
GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW \pm 5 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2	SUB-SECTION- QA Civil, Q-29	PAGE 1

Disclaimer for Indicative Vendor List

- 1.1 Reasonable efforts have been made to collate the sub-vendors proposed by the various main contractors from time to time against different Projects/Packages and accepted by NTPC for various items. However, in case of error/omission, if any, and represented by the successful bidder this will be addressed during the execution of the contract based on the material evidence available with NTPC / Main Contractor.
- 1.2 The approved sub-vendor list drawn is not based on NTPC driven enlistment process but based on the sub- vendors proposed by various Main Contractors. As such, it is possible that some of the Suppliers/Manufacturers who may be involved in similar work/process may not be appearing in the list as such sub-vendors may not have been proposed by Main Contractors against NTPC Contracts.
- 1.3 In case the successful bidder chooses to propose additional sub-vendors with relevant experience after the award of the contract such sub-vendors will be considered in terms of Clause no: 19.1 of GCC, provided the proposals are received sufficiently in time: 90 days prior to ordering date of a Bought Out Items/Start of Manufacturing so as not to impede the progress of the contract.
- 1.4 Sub-vendors have been grouped under different categories of items. It is possible that an item characterized by certain specific features such as range and type required as per Main Contractor's design requirements may not be in the range of the listed sub-vendor's manufacturing process/capability. As such the main contractor to ascertain the vendor's capability to meet his specific requirements before considering a sub-vendor.

GREAT NICOBAR ISLAND GAS ENGINE POWER PROJECT (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2	SUB-SECTION- Q-30 INDICATIVE VENDOR LIST	Page 1 of 2
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- 1.5 It is to be noted by the bidders that any shortfall in contract performance attributable to the sub-vendor listed will not absolve the contractor from his contractual obligations in any manner.
- 1.6 The approval was granted based on the evaluation of relevant capabilities and facilities possessed by the sub-vendor at the time of evaluation. Also, some of the sub-vendors may not be active. As such, the successful bidder is to carry out his own due diligence before considering the listed sub-vendor for subletting: the current status of the sub-vendor, the continued availability of productive resources including Human Resources.
- 1.7 The list of sub-vendors is periodically revised to include new sub-vendors. Such a revision may also see a deletion of certain sub-vendors who may have been disqualified on grounds of inadequate performance or banned in line with NTPC's banning policy. The then current list will be shared with the successful bidder immediately on award.

GREAT NICOBAR ISLAND NICOBAR ISLAND GAS POWER (108 MW ±5 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART- B Bid Doc. No.: CS-6401-001-2	SUB-SECTION-Q-30 INDICATIVE VENDOR LIST	Page 2 of 2
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S. N. क्र.सं.	Item / मद	QP/ Insp. Cat. क्यूपी/ निरी. श्रेणी.	QP No. / क्यूपी. सं.	QP Sub. Schedu le क्यूपी उप.अनु सूचि	Proposed sub-supplier/ प्रस्तावित उप आपूर्तिकर्ता	Place/ स्थान	Sub-suppliers approval status / category उप आपूर्तिकर्ता के अनुमोदन की स्थिति /श्रेणी (NOTE-1)	Sub-supplier Details submission schedule/ उप आपूर्तिकर्ता के विवरण प्रस्तुतीकरण की सूची	Remarks/ टिप्पणी
5	PIPES-MS- (BLACK/ GI) AS PER IS IS:3589 >1000NB	I			WELSPUN	RAISEN	A		SAW UP TO 3632 OD , THICKNESS 16 MM, SAW UP TO 1600 OD , THICKNESS 25 MM
					WELSPUN	BHARUCH	A		SAW UPTO 1300 NB
					MAN INDUSTRIES	INDORE	A		SAW UPTO 1400 NB
					MUKAT TANKS & VESSELS	TARAPUR	A		SAW 200 TO 1200 NB
					MUKAT PIPES	RAJPURA	A		SAW UPTO 1800 NB
					LALIT PIPES AND PIPES LTD	THANE	A		SAW 350 TO 1400 NB
					RATNAMANI	CHATRAL	A		SAW 600 TO 2600 NB
					RATNAMANI	KUTCH	A		SAW 400 TO 3600 NB
					PSL HOLDINGS LIMITED	DAMAN	A		SAW 450 TO 1600 NB
					PSL INTERNATIONAL LTD.	CHENNAI	A		SAW 450 TO 1600 NB
					PSL LIMITED	KUTCH	A		SAW 450 TO 1600 NB
					PSL LIMITED	VISAKHAPATNAM	A		SAW 450 TO 1600 NB
					JCO PIPES	CHHINDWARA	A		SAW UPTO 1600 NB
					SURYA ROSHNI	ANJAR	A		SAW UP TO 2032 OD
					JINDAL SAW LTD	BELLARY	A		SAW UP TO 3632 OD , THICKNESS 16 MM
					Narmada Tube Pvt. Ltd.(Earlier Samshi Pipe Industry Ltd)	Vadodara	A		450mm to 2540mm OD THk. up to 19.1mm and Grade Fe 410 (Spirally welded-Helical Seam using SAW Process)
6	PIPES & FITTINGS-GRP	I			CAPACITE STRUCURES PVT LTD	THANE	A		406.4 MM TO 3874 MM OD
					EPP COMPOSITES PVT LTD	RAJKOT	A		UP TO 900MM
					GRAPHITE INDIA	NASIK	A		UP TO 1000MM
					SHRIRAM SEPL COMPOSITES LTD	CHENNAI	A		UP TO 1100MM
					BALAJI FIBER REINFORCE PVT LIMITED	VADODARA	A		UP TO 650MM
					MEGHA FIBRE GLASS INDUSTRIES PVT LTD	MEDAK	A		UP TO 900MM
7	SERVICE VESSEL-CPU & OTHER PR VESSELS >= 10 BAR WORKING PRESSURE	I			DRIPLEX WATER ENGINEERING INTERNATIONAL PVT LIMITED	BHADARBAD	A		
					BGR ENERGY SYSTEMS LTD (ENVIRONMENTAL ENGG. DIV.)	PONNERI	A		UPTO 3000MM DIA & THICKNESS UPTO 28 MM
					ISHAN EQUIPMENTS PRIVATE LIMITED	VADODARA	A		UPTO 2900 MM DIA & THICKNESS UPTO 28 MM
					JASMINO POLYMERTECH PVT LTD	TALOJA	A		DIA 2800MM, THICNKESS 25MM DESIGN PRESSURE UP TO 47.5 KSC
					MAHIMA UDYOG	HARIDWAR	A		DIA UP TO 2900 MM , THICKNESS UPTO 29 MM
					SV Fabricators	Navi Mumbai	A		
8	PUMPS- HORIZONTAL & VERTICAL CENTRIFUGAL -UP TO 300KW (< 10 KW , CAT-III, MAIN CONTRACTOR APPROVED SOURCE)	(≥10KW & < 90 KW CAT-II , ≥ 90 KW CAT-I)			KIRLOSKAR BROTHERS LTD	KIRLOSKARWADI	A		
					WILO MATHER & PLATT	SATARA	A		Vertical Wet Pit & Non-Pull-Out Type Pump Set – 200 Kw Motor rating, Horizontal Centrifugal Pump 2.2 KW
					WILO MATHER & PLATT	KOLHAPUR	A		
					SAM TURBO	COIMBATORE	A		FLOW UP TO 1580 CUM/HR, HEAD 234M AND POWER RATING UP TO 425 KW
					FLOWMORE LTD	GHAZIABAD	A		
					BEST AND CROMPTON	CHENNAI	A		
					JYOTI LTD	VADODARA	A		
					WPIL	GHAZIABAD	A		
					KISHORE PUMPS	PUNE	A		UPTO 500M3/HR ONLY RUBBERLINED PUMPS ALSO
					GRUNDFOS PUMPS INDIA PVT LTD	CHENNAI	A		HORIZONTAL UP TO 30 KW ONLY AND VERTICAL UP TO 45 KW ONLY (FOR APPLICATIONS WHERE NPISH IS NOT REQUIRED)
					SINTECH PRECISION PRODUCTS LTD	GHAZIABAD	A		HORIZONTAL UP TO 400 KW MOTOR RATING AND VERTICAL UP TO 30 KW MOTOR RATING
					KSB	PUNE	A		
					KSB	NASHIK	A		
					FLOWSERVE INDIA CONTROLS PVT LTD	COIMBATORE	A		HOIZONTAL CENTRIFUGAL PUMP UP TO 75 KW ONLY
					SU MOTOR	MUMBAI	A		HORIZONATL UPTO 500M3/HR ONLY RUBBERLINED PUMPS AND VERTICAL CENTRIFUGAL PUMPS UP TO 100CMH ONLY
					FLOWCON ENGINEER INDIA PRIVATE LIMITED	COIMBATORE	A		FLOW UP TO 1580 CUM/HR AND POWER RATING UP TO 425 KW
					XYLEM WATER SOLUTIONS INDIA PVT LTD	Vadodara	A		For Vertical Pump
					MBH Pumps (GUJ) Pvt Ltd	AHMEDABAD	A		37.5 KW
					VARAT PUMP AND MACHINARY PVT LTD	HOWRAH	A		HYDRANT SPRAY, BOOSTER PUMP & JOCKEY PUMP
					BHARAT PUMPS AND COMPRESSORS	NAINI	A		FLOW UP TO 2200 M3/HR AND HEAD UP TO 60 MWC
					FLOWMORE LTD	GHAZIABAD	A		

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9	PUMPS -VT -UP TO 300KW	I			KIRLOSKAR BROTHERS LIMITED	KIRLOSKARWADI	A		
					WPIL LTD	KOLKATA	A		
					WPIL LTD	GHAZIABAD	A		
					JYOTI LTD	VADODARA	A		
					XYLEM WATER SOLUTIONS INDIA PVT LTD	VADODARA	A		
					FLOWSERVE INDIA CONTROLS PVT LTD	COIMBATORE	A		UP TO 1025 KW
					SINTECH PRECISION PRODUCTS LTD	GHAZIABAD	A		75 KW
					WILO MATHER & PLATT	PUNE	A		
10	VALVE-DUAL PLATE CHECK > 600MM OR CLASS > 300 (VALVE-DUAL PLATE CHECK UP TO 600MM & CLASS 300: CAT-II & MAIN CONTRACTOR APPROVED SOURCES)	I			ADVANCE VALVE PVT LTD	GR. NOIDA	A		DUAL PLATE CHECK VALVES CI UPTO 1000 NB CLASS 125, DUPLEX SS UP TO 600NB CLASS 600.
					LEADER VALVES	JALANDHAR	A		UP TO 900MM CLASS 150 , SS 200NB CLASS#300
					R & D MULTIPLE	VALSAD	A		CI/ CS UP TO 800NB PN 10
11	VALVE-BALL > 100 MM OR CLASS > 800; (VALVE- BALL UP TO 100 MM & CLASS 800:CAT-II & MAIN CONTRACTOR APPROVED SOURCES)	I			BDK VALVES PVT LTDB (EARLIER SWIMS TECHNOLOGIES)	HUBLI	A		SS BALL VALVES UP TO 500MM AND CLASS #600, CS BALL VALVES UP TO 250 MM AND CLASS# 900, CS/ SS BALL VALVES UP TO 100 MM AND CLASS # 1500.
					MICRO FINISH VALVES PVT. LTD.	HUBLI	A		400NB CLASS#600 AND UP TO 600NB CLASS#300
					FLOW CHEM INDUSTRIES	KALOL	A		100NB CLASS#600,200NB CLASS#300, 50 NB CLASS#800
					L&T VALVES LIMITED	KANCHEEPURAM	A		UPTO 150NB, CLASS #150/300, AND UPTO 50NB, CLASS #800
					PRECISSION ENGG CO VALVES PVT LTD	NASIK	A		FCS UP TO 50NB CLASS 800, CCS UP TO 400NB CLASS 150.
					WELLCAST INDUSTRIES	AHMEDABAD	A		SIZE 150 NB & PR CLASS 150
					A V VALVES	AGRA	A		Size up to 250 NB & Class 150
					BELGAUM AQUA VALVE PVT LTD	BELGAON	A		FCS UP TO 50NB CLASS 800, CCS UP TO 200NB CLASS 150.
					G M ENGINEERING PRIVATE LTD	RAJKOT	A		UP TO 400 NB AND CLASS #600
					INTERVALVE POONAWALA LTD	PUNE	A		SGI / CI / D2 1400MM PN10, SGI / CI 1000MM PN16,CS/SS 500MM PN16, SS 400MM CLASS#300, MS FABRICATED UPTO 2000NB, PN 6
12	VALVE-BUTTERFLY > 600MM OR CLASS>150 (VALVE-BUTTERFLY UP TO 600MM & CLASS 150::CAT-II & MAIN CONTRACTOR APPROVED SOURCES)	I			BDK VALVE PRIVATE LIMITED (SWIMS TECHNOLOGIES)	HUBLI	A		CI/ DI BUTTERFLY VALVE UP TO 1000MM AND PN16 AND UP TO 1800MM AND PN10,CCS UP TO 1050MM CLASS 150 AND UP TO 1800MM AND PN16 SS - UP TO 400NB PN-16 ,FABRICATED 800MM CLASS#150. & FABRICATED BUTTERFLY VALVE 2800 NB, CLASS 75B/PN6
					PENTAIR VALVES	HALOL	A		FOR SS UP TO 500 NB PN-10, CI- UP TO 900NB PN-10, UP TO 500NB PN-16, 450MM CLASS#300., MS FABRICATED UPTO 2800NB, PN6.
					FOURES ENGINEERING	BANGALORE	A		CAST SGI/CI/ MS FABRICATED- UP TO 1200 PN-10, UP TO 350 PN-16 ,2400 MM PN6/CLASS150 SS - UP TO 300NB PN-10,MS FABRICATED UPTO 2700NB CLASS # 75
					KIRLOSKAR BROTHERS LTD	KIRLOSKERWADI	A		CS CAST 900 NB PN20 and MS FABRICATED 2200NB, PN10.
					R & D MULTIPLE	VALSAD	A		CAST SGI/CI/MS FABRICATED- UP TO 1800 MM PN-10/CLASS # 75, ,1100MM PN25,1400MM CLASS#150 ,MS FABRICATED UPTO 2800NB CLASS # 75
					ADVANCE VALVES PVT LTD	GREATER NOIDA	A		METAL SEATED, TRIPLE ECCENTRIC, SS BFV OF SIZE UPTO 100NB, AND PRESSURE RATING UPTO CLASS #300.
					BRAY CONTROLS INDIA PVT. LTD	KANCHIPURAM	A		UPTO 450 MM AND CLASS#600
					INSTRUMENTATION LTD.	PALAKKAD	A		UPTO 2200NB CLASS # 75
					A V VALVE	AGRA	A		CI Butterfly Valve Size upto 800NB & 150 Class
					HAWA ENGINEERS	AHMEDABAD	A		CI/ CS & FABRICATED UPTO 1200MM, CLASS #150, SS UPTO 250MM, CLASS#150
					CRANE PROCESS FLOW	SATARA	A		UP TO 900MM PN10 and Butterfly valve 450NB CLASS 300
					L & T VALVES LIMITED	ENATHUR, KACHEEPURAM	A		FABRICATED DESIGN UP TO 2700MM CLASS 150
					DEMBLA VALVES	THANE	A		UP TO 2200MM CLASS#75
					GM ENGINEERING PRIVATE LTD	RAJKOT	A		FABRICATED BUTTERFLY VALVE UP TO 2800 NB, CLASS 75B/PN6
					DELVAL FLOW CONTROLS PVT LTD	SATARA	A		SIZE UPTO 600NB, PN16/CLASS 150 & 1000NB, PN10
					LEADER VALVES	JALANDHAR	A		CS GATE 600MM CLASS#600, SS GLOBE 600MM CLASS#600, CS CHECK 600MM AND CLASS#600

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S. N. क्र.सं.	Item / मद	QP/ Insp. Cat. क्यूपी/ निरी. श्रेणी.	QP No. / क्यूपी. सं.	QP Sub. Schedu le क्यूपी	Proposed sub-supplier/ प्रस्तावित उप आपूर्तिकर्ता	Place/ स्थान	Sub-suppliers approval status / category उप आपूर्तिकर्ता के अनुमोदन की स्थिति /श्रेणी (NOTE-1)	Sub- supplier Details submissio n schedu le/ उप आपूर्तिकर्ता के विवरण प्रस्तुतीकर ण की प्रकी	Remarks/ टिप्पणी
13	VALVE-CONVENTIONAL GATE / GLOBE / CHECK(> 600NB OR CLASS > 300 AND ≤ 600 NB & CLASS 300 CAT-III, MAIN CONTRACTOR APPROVED SOURCE)	II			HAWA ENGINEERS	AHMEDABAD	A		FCS / FSS 50 NB CLASS 800.
					FOURES ENGINEERINGS	THANE	A		400NB CLASS 600 AND 50NB CLASS 800.
					BHEL IVP	GOINDWAL	A		GATE UP TO 300 NB CLASS 600. GLOBE 250 NB CLASS 400, CHECK 150NB CLASS 600.
					HITECH ENGG PVT LTD	AHEMDABAD	A		50 NB CLASS 800.
					KSB PUMPS LTD	COIMBATORE	A		300NB CLASS 2500.
					NITON VALVES INDIA PVT LTD	NAVI MUMBAI / AURANGABAD	A		CS GATE 900 NB CLASS 600, CHECK 300 NB CLASS 600.
					L&T VALVES LIMITED	ENATHUR, KACHEEPURAM	A		GATE VALVE SIZE UP TO 38" & CLASS UP TO 3200, GLOBE VALVE SIZE UP TO 16" & CLASS UP TO 4500 & CHECK VALVE SIZE UP TO 36" & CLASS UP TO 4500
					GM ENGINEERING PRIVATE LTD	RAJKOT	A		Globe Valve - 15NB & Class 800 and Check valve-50NB & Class-800
14	VALVE- DIAPHGRAGM TYPE	I			BDK VALVES PVT LTDB (EARLIER SWIMS TECHNOLOGIES)	HUBLI	A		CONVENTIONAL CCS GATE / GLOBE / CHECK VALVES UP TO 600MM AND CLASS # 1500, CSS GATE/ GLOBE/ CHECK VALVES UP TO 200MM AND CLASS # 600, FCS GATE / GLOBE / CHECK VALVES UP TO 50MM AND CLASS # 2500.
					CRANE PROCESS FLOW	SATARA	A		UP TO 300NB PN10
					BDK VALVES PVT LTDB (EARLIER SWIMS TECHNOLOGIES)	HUBLI	A		UPTO 250 NB - PN 10, 350MM PN6
					PROCON ENGINEERS	MUMBAI	A		UPTO 200 NB AND PN 10/CLASS #150 & 250NB- PN-6 RATING
15	VALVE-PLUG > 100 MM OR CLASS > 800(VALVE- PLUG UP TO 100 MM & CLASS 800:CAT-II & MAIN CONTRACTOR APPROVED SOURCES)	I			BDK VALVES PVT LTDB (EARLIER SWIMS TECHNOLOGIES)	HUBLI	A		SOFT SEATED 400MM AND CLASS #150, 300NB CLASS#300
					XOMOX SANMAR	TRICHY	A		UP TO 600MM AND CLASS#300
					FLOWERVE INDIA CONTROLS	CHENNAI	A		METALLIC SEATED 400NB CLASS#150, 300NB CLASS #300, 50NB CLASS #800
16	PUMP -SUBMERSIBLE/SUMP>= 30KW < 30 KW CAT-II, MAIN CONTRACTOR APPROVED	I			KSB	NASHIK	A		130 KW
					KIRLOSKAR BROTHERS LTD	KIRLOSKARWADI	A		
					AQUA MACHINERY	AHMEDABAD	A		UP TO 235 KW
					KISHORE	PUNE	A		
					SU MOTORS	MUMBAI	A		
					Darling Pump	Indore	A		UPTO 45KW RATING, NON-CLOG TYPE
					WPIL	GHAZIABAD	A		
17	RUBBER EXPANSION JOINT>=1600NB (RUBBER EXPANSION JOINT < 1600NB: CAT-II & MAIN CONTRACTOR APPROVED SOURCES)	I			CORI ENGINEERS PVT LTD	CHENNAI	A		UPTO 2800 MM
					SRM EXOFLEX PVT LTD	KOLKATA	A		UPTO 2800 MM
18	DELUGE VALVE WITH TRIMS	I			HD FIRE	THANE/JALGAON	A		
					CARRIER	GURGAON	A		FOR PISTON TYPE DELUGE VALVE ONLY
19	INERT GAS EXTINGUISHING SYSTEM	II			ANSUL	USA	A		
					KIDDE (GINGEKERR)	UK	A		
					NAFFCO	UAE	A		
					MINIMAX Gmbh & Co. KG	GERMANY	A		
					TOTAL WALTHER	GERMANY	A		
					SWASTIK SYNERGY ENGINEERING Pvt Ltd	KHOPOLI, RAIGARH	A		1.Discharge Hose, Size: Length 450 mm, ID-1/2", Pressure:60 Bar, MOC: Synthetic Rubber, End fittings: Stainless Steel SS304
									2. Nozzle 360° & 180 °
									Size: up to G 1 1/4", Pressure:60 Bar, MOC: Stainless Steel SS304.
									3. Non return Valve, Size: G ¾", Pressure: 60 Bar, MOC: Stainless Steel SS304
20	ALARM VALVE WITH TRIMS	II							4. Cylinder Valve, Size: 25E-DIN EN ISO 11363-1, Pressure:300 Bar, MOC: Brass IS319 Grade 1
									5. Bleeder Valve, Size: G 1/8" (M), Pressure: 300 Bar, MOC: Stainless Steel SS304
21	FOAM SYSTEM(BLADDER TYPE)	I							6. Directional Valve, Size: up to G3", Pressure:60 Bar, MOC: Stainless Steel SS304
									7.Pressure relief safety Valve, Size: G ½", Pressure:90 Bar, MOC: Stainless Steel SS304
					NOHMI BOSAI	JAPAN	A		
					HD FIRE	THANE	A		
					HD FIRE	JALGAON	A		
					HD FIRE	JALGAON	A		
					FIRETECH	RATNAGIRI	A		

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22	FIRE TENDER	I			WADIA BODY BUILDERS	AHEMDABAD	A		
					AAREL INDUSTRIES	INDORE	A		
					AMBALA COACH	AMBALA	A		
					VIJAY FIRE	UMBERGAON	A		
23	CENTRIFUGAL FAN (≥10KW), (< 10 KW , CAT-II, MAIN CONTRACTOR APPROVED SOURCE), MOTOR FROM NTPC ACCEPTED SOURCE	I			MARATHON ELECTRIC MOTOR(I) LTD	KOLKATA	A		UP TO 50000 CMH
					HOWDEN AIR AND GAS INDIA PVT LTD(FORMERLY HOWDEN SOLYVENT INDIA PVT LTD)	CHENNAI	A		UP TO 200000 CMH
					ALMONAROD (P) LIMITED	CHENNAI	A		UP TO 60000 CMH
					PATEL AIRFLOW	VATWA, AHMEDABAD	A		UP TO 250000 CMH
					CE DOCTOR VENTILATOR PVT LTD	AHMEDABAD	A		UP TO 150000 CMH
					WOLTER VENTILATORS INDIA (P) LTD	BHIWADI,	A		UP TO 200000 CMH
					C DOCTOR &CO PVT LTD	KOLKATA	A		UP TO 250000 CMH
					SUVIDHA AIR SOLUTIONS PVT LTD	AHMEDABAD	A		UP TO 190000 CMH
					SUBURBAN INDUSTRIAL WORKS PVT. LTD	KOLKATA	A		UP TO 100000 CMH
					KRUGER VENTILATION INDUSTRIES (I) PVT LTD	THANE	A		UP TO 90000 CMH
					TAP ENGINEERING	KANCHEEPURAM	A		UP TO 53000 CMH
					SOLYVENT FLAKT	KOLKATA	A		UP TO 200000 CMH
					ADVANCE VENTILATION PVT LTD	SONEPAT	A		UP TO 250000 CMH
					M/s Dustech Engineers Pvt. Ltd	Palwal	A		UP TO 100000 CMH
					SK SYSTEMS PVT LTD	SONEPAT	A		UP TO 250000 CMH
24	GAS ENGINE	I			NO APPROVED VENDOR AVAILABLE, SHALL BE REVIEWE & APPROVED AFTER AWARD OF CONTRACT				
25	3 LPE COATED PIPE	I			SAIL	ROURKELA	A		
					RATNAMANI	KUTCH	A		UP TO 1100 NB
					JINDAL SAW LTD	BELLARY	A		UP TO 1300 MM
					WELSPUN	RAISEN	A		1000 mm dia, wall Thickness up to 8.8mm and 3 LPE coating (thickness 3 mm)
					ArcelorMittal Nippon steel India Ltd	HAZIRA	A		UP TO 910 MM
					PSL LTD	KUTCH/ VIZAC	A		UP TO 1100 NB
26	PLATE HEAT EXCHANGER	I			TRANTER INDIA	PUNE	A		1. (PHE, size up to 3011mmX1000mmX0.6mm) 2. Design/Drawing of PHE shall be vetted by Tranter Swiden or Tranter USA. 3. H.T. Plates pressed at LHE facilities(S Korea) using SS Coils from their regular sources namely POSCO(S Korea) / Ottokompu-Swiden/Finland or from other NTPC agreed sources with correlated MTCs. 4. Gaskets from M/s TRP-UK/GISALAVED-Swiden-Trelieborg-Polaska/Mexico/any other NTPC agreed source with correlated MTC
					ALFA LAVAL INDIA LTD.	SATARA	A		1. Plate Heat Exchangers (PHEs) Model – T45, HT Plate Dimensions: L-2992 mm x W-1250 mm XTH- 0.6 mm and Model – T35, HT Plate Dimensions: L-2350 mm x W-1000 mm x TH-0.6 mm. 2. Design of PHE model shall be of Alfa Laval-Sweden. 3. For Model T35 & size up to (L-2350mmXW-1000mmXTH-0.6mm) HT Plates shall be single step pressed at Alfa Laval, Satara using CR SS Coils from NTPC agreed source such as Jindal Stainless ltd with correlated TC. For Model T45(L-2992mmXW-1250mmXTH-0.6mm) HT Plates shall be single step pressed at Alfa Laval, Sweden using CR SS coil for HT Plates sourced from Outokumpu, Sweden/ Aperam, France with correlated TC. 4. Gaskets shall be sourced from TRP-India/UK and Gislated-
					IDMC	ANAND	A		HT PLATES & GASKETS FROM SONDEX DENMARK


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					DANFOSS INDUSTRIES PVT. LTD(FORMERLY SONDEX HEAT EXCHANGER INDIA PVT. LTD.)	VADODARA	A		HT PLATES FROM DANFOSS DENMARK & GASKETS FROM DANFOSS DENMARK/POLAND (MODEL SDN 352) SIZE UP TO 2333MMX990MMX0.6MM
					Mytec Co. Ltd.	Korea	A		Size up to 1753 mmX 658 mmX 0.6mm With HT Plates & Gaskets from Sondex-Denmark
					KELVION INDIA PVT LTD	PUNE	A		MODEL NT350L, SIZE UP TO 2812MMX995MMX0.6MM
					GEA Ecoflex GmbH	Germany	A		
					JINDAL SAW(I161)	KUTCH	A		UP TO DN 900 CLASS K7 & K9
27	DI(Ductile Iron) PIPE & FITTINGS	I			IAI BALAJI(I156)	BARDWAN	A		UP TO DN 900 CLASS K7 & K9
					ELETROSTEEL CASTINGS LTD.	SRIKALAHASTHI	A		DI PIPES-900NB K7
					ELETRO STEEL	KOLKATA	A		
28	AIR COPMPRESSOR: OIL FREE CENTRIFUGAL COMPRESSOR	I			INGERSOLL RAND INDIA	AHEMDABAD	A		Capacity Upto 60 NM3/Minute @ Pr 8 bar
					KIRLOSKAR PNEUMATIC COMPANY LTD	PUNE	A		Capacity up to 65 Nm3/min and pressure rating up to 8.0 kg/cm2
29	OIL FREE SCREW TYPE AIR COMPRESSORS	I			ATLAS COPCO	BELGIUM (ASSEMBLING & TESTING AT ATLOS COPCO ,PUNE).	A		Capacity Upto 75 NM3/Minute @ PR 8.0 KG/CM2(g) and 100 NM3/Minute @ PR 4 KG/CM2
		I			INGERSOL RAND INDIA	AHMEDABAD	A		UPTO MODELSH 300 (36 NM3/MIN) . AIR ENDS FROM GHH RAND - GERMANY & OTHER COMPONENTS FROM IR'S GLOBAL SOURCES ASSEMBLY & TESTING AT INGERSOL- AHMEDABAD
		I			ELGI	COIMBATORE	A		UPTO 2830 CFM,
		I			AERZEN MACHINES	VADODARA	A		6520 M3/Hr @ 2.58 bar
		I			KIRLOSKER PNEUMATIC COMP LTD	PUNE	A		FLOW CAPACITY 65 NM3/MIN AND PRESSURE RATING 8 KG/CM2
30	AIR DRYER	I			SUMMITS HYGRONICS	COIMBATORE	A		FOR REFRIGERANT DRYER, 11893 M3/HR , REGENERATIVE DRYERS BLOWER REACTIVATED TYPE 2123 M3/HR AND REGENERATIVE DRYERS HOC TYPE 5820 M3/HR
					MELLCON ENGRS PVT LTD	GR NOIDA	A		Refrigerant type 7285 m3/hr & REGENERATIVE DRYERS HOC TYPE 2548 M3/HR
					DELAIR INDIA LTD	GURGAON	A		Refrigerant type 7500 m3/hr & REGENERATIVE DRYERS HOC TYPE 3000 M3/HR
					SUMESH PETROLEUM	VADODARA	A		100 CFM(169 M3/HR) & 7 KG/CM2
					ATLAS COPCO	BELGIUM(ASSLY & TESTING AT PUNE)	A		MODEL UP TO FD1200
					INDCON	DELHI	A		Regenerative dryer2500 m3/hr HOC & DECICANT TYPE
31	SCREW CHILLER	II			TRIDENT PNEUMATIC PVT LTD	COIMBATORE	A		Refrigerant type 10000 m3/hr & REGENERATIVE DRYERS BHR TYPE 1000 M3/HR
					KIRLOSKAR CHILLER	PUNE	A		UP TO 350TR
					DAIKIN	NEEMRANA	A		UP TO 185 TR
					KIRLOSKAR CHILLER PVT LTD	PUNE	A		Up to 350TR
					YORK INTERNATIONAL	TEXAS ,USA	A		UP TO 300TR
					TRANE COMPANY	COLORADO USA	A		UP TO 225 TR
					DUNHAM-BUSH	MALASYIA	A		UP TO 350TR
					BLUE STAR (COMPRESSOR FROM HANBEL- TAIWAN)	WADA	A		SCREW CHILLER UP TO 282TR
32	Mettalic Expansion Bellows	II			MB METTALIC BELLOWS	CHENNAI	A		
					SUR Industries	KOLKATA	A		
					Flexicon	Vadodara	A		For size upto 2200 NB
					Witzemann	Germany	A		
					Munro & Miller	UK	A		
					Flexatherm	Vadodara	A		For size upto 2200 NB
					Bird Precision	UK	A		
					Metallic Bellows	Chennai	A		For size up to 1600 NB
					Athulya Bellows and Engineering Pvt. Ltd	Vadodara	A		For size up to 3400 NB
					HKR	S Korea	A		
33	Conveying Compressor (Reciprocating)	I			LONE STAR	CHENNAI	A		
					KIRLOSKAR PNEUMATICS	PUNE	A		
					INGERSOLL RAND	AHEMDABAD	A		

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					ATLAS COPCO(CHICAGO PNEUMATIC BRAND)	PUNE	A		
34	ALLOY CAST IRON PIPE, FITTINGS AND LINER	I			CRAWLEY & RAY	KOLKATA	A		
					ALLIED FOUNDRIES	BELGAUM	A		
					PARAMOUNT CASTINGS	NAGPUR	A		
					NORTHERN ALLOY	BHAVNAGAR	A		
					MENON METALLIK	KOLHAPUR	A		
					KOLHAPUR STEEL	KOLHAPUR	A		
					AQUA ALLOY	KOLHAPUR	A		
					MARTO PEARL	HYDERABAD	A		
					R.R.L	HOWRAH	A		
					CONCAST ENGINEERING	BURDWAN, WB	A		
					NATRAJ IRON & CASTINGS	DHANBAD	A		
					ETA Manufacturers Private Limited	Bahadurpur	A		
					ABHIPRIYA BUSINESS	PANT NAGAR	A		
35	WEIGH BRIDGE				RICELAKE WEIGHNING SYSTEM	PITHAMPUR	A		100 MT PITLESS WEIGH BRIDGE
36	CAST IRON PIPE	I			ELECTROSTEEL	CHENNAI	A		UPTO 450 NB
					KESORAM	KOLKATA	A		UPTO 350 NB
					IISCO	KULTI	A		
					KAPILANSH DHATU UDYOG	NAGPUR	A		APPROVED UPTO 350 NB.
					KUSHA LAVA	VIJAYWADA	A		FOR NON STD. SIZE
37	PULLEYS	I			ELECON	V V NAGAR	A		
					PROMAC	BANGALORE	A		
					MBE	KUMARDHUBI	A		
					BTL EPC	KOLKATA	A		
					TNS HEAVY	CHENNAI	A		
					KALI	THIRUBUVANAM	A		
					THYSSENKRUPP	HYDERABAD / PUNE	A		
					L & T - EWL	KANCHEEPURAM	A		
					V V N MFG	V V NAGAR	A		Upto 800 NB Dia
					ROLLWELL	HINDUPUR	A		
38	HELICAL GEARBOX	I			TRF	JAMSHEDPUR	A		
					SHANTI GEARS	COIMBATORE	A		Upto size 560
					ELECON	V V NAGAR	A		
					SIEMENS (FLENDER)	KHARAGPUR	A		
					PREMIUM TRANMISSION LTD	PUNE/FALTA	A		Up to size 710 / 450
					SIEMENS (FLENDER)	GERMANY	A		
					FLENDER DRIVES PRIVATE LIMITED	KANCHEEPURAM	A		BEVEL HELICAL GEAR BOX UP TO 90 KW
39	FLUID COUPLING (SCOOP AND TRACTION TYPE)	I			M/s Bonfiglioli Transmissions Private Limited	CHENNAI	A		
					NEW ALLENBURY WORKS	KOLKATA	A		
					FLUIDOMAT	DEWAS	A		Scoop type upto SC-1330
					PTL	AURANGABAD	A		SCOOP TYPE UPTO PST 1150
					ELECON	V V NAGAR	A		Scoop type upto model ESC 760. 1. As part of Type test M/s Elecon will demonstrate Scoop tube in & Scoop tube out 1000 times on first coupling of each model. 2. M/s Elecon will conduct full load test for each type and model of coupling as per approved quality plan.
					VOITH	HYDERABAD	A		SCOOP TYPE UPTO SVNL 1330
					INDIANA GRATINGS PVT. LTD.	PUNE	A		
					JINDAL STEEL & POWER LTD.	RAIGARH	A		
					BABY ENGG. PVT. LTD.	TRICHY	A		
					REGIONAL ENGG. WORKS	TRICHY	A		
					AJANTHA FABS	MATHURA	A		
					CAPACITE STRUCTURES LTD.	THANE	A		
					MIURA INFRASTRUCTURE PVT. LTD.	BHILAI	A		
					SHIVAM HITECH STEELS PVT. LTD	BHILAI	A		
					TECHNOFAB MANUFACTURING LTD.	CHENNAI	A		
					JSW SEVERFIELD STRUCTURES LTD(ISSL)	BELLARY	A		
					ALLIANCE INTEGRATED METALIKS LTD(AIML)	RAJPURA	A		
					ATMASTCO PVT LTD	DURGAPUR	A		

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40	SHOP FABRICATED STRUCTURE (> 5T SINGLE PIECE) Fabricated Steel Structure (Single Piece upto 5 MT and Rolled Section-CAT-III)	I			APEX BUILDSYS LTD	NAGPUR	A		
					COREFAB PROJECTS PVT LTD	BHILAI	A		
					KOTHARI CHEMICALS	BHILAI	A		
					FEDDERS LLOYD CORPORATION LTD	SIKANDRABAD	A		
					ARCELOR MITTAL DHAMM PROCESSING PVT LTD	RANIPET	A		
					ARTSON ENGINEERING	NASIK	A		
					ARTSON ENGINEERING	NAGPUR	A		
					HEAVY ENGINEERING WORKS	REWA, MP	A		
					ARCELORMITTAL NIPPON STEEL INDIA LTD	CHENNAI	A		
					TRIDENT FABRICATORS PVT LTD	ROURKELA	A		
					GISF ENGINEERING PVT LTD	YAMUNA NAGAR	A		
					METALFAB HITECH	NAGPUR	A		
					SUPERTECH INDIA	G.NOIDA	A		
					GOODLUCK STEEL	SIKANDRABAD	A		
					BTL	KOLKATA	A		
					BTL	DURGAPUR	A		
					AMIYA COMMERCE	KOLKATA	A		
					NAMDHARI INDUSTRIAL	LUDHIANA	A		
					Ambabhawani Fab Engg Works LLP	Rajnandgan	A		
					SRISHTI METALS PVT. LTD.	SONEPAT	A		(SINGLE ITEM UPTO 10MT)
					ANIL STEEL PVT. LTD.	SONEPAT	A		(SINGLE ITEM UPTO 15 MT)
					Jagdamba Structurals Pvt. Ltd.	RAIGARH	A		(SINGLE ITEM UPTO 35 MT)
					Kalyani Alloy Casting	NADIA	A		(SINGLE ITEM UPTO 15 MT)
					Golden Engineering Industries	Durg	A		Single piece up to 5 MT
					Jindal Prefab	Rewari	A		(SINGLE ITEM WT UPTO 08MT)
					JINDAL STEEL & POWER LTD.	Angul	A		
					INDIANA GRATINGS	PUNE	A		(single piece maximum weight up to 30.00 MT- Plot No D-7 and single piece maximum weight up to 65.00 MT- Plot No C-63)
					Zetwerk Manufacturing Business Private Limited	WARDHA	A		MANUFACTURING OF WELDED TYPE STRUCTURES I.E. AUTOWELDED BEAMS BRACING AND COLUMNS (UPTO 15T)
					THYSSENKRUPP INDUSTRIES INDIA	HYDERABAD	A		
41	PIPE-SS ASTM A 312(ERW/ SEAMLESS) (*TCs TO BE VERIFIED BY MAIN CONTRACTOR)	ERW-II/ SEAMLESS-III*			REMI	TARAPUR	A		ERW UPTO 400 NB,SEAMLESS UP TO 200NB
					RATNAMANI	MEHSANA	A		ERW UPTO 500 NB, SS SEAMLESS - OD up to 168.3, thickness up to 3.4 mm, as per ASTM SA 312 Grade-TP 304
					RATNAMANI	KUTCH	A		ERW UPTO 400 NB, SEAMLESS UPTO 50 NB ONLY, ARC WELDED UP TO 450NB
					BHANDARI FOILS & TUBES LIMITED	DEWAS	A		ERW UP TO 300NB
					APEX	BEHRRORE	A		ERW UPTO 400 NB, SEAMLESS UPTO 50 NB.
					PRAKASH STEELAGE	SILVASA	A		ERW UP TO 203NB
					SHUBHLAXMI METALS AND TUBES	UMBERGAON	A		SEAMLESS UP TO 150MM and ERW UP TO 250 NB Sch 40S
42	PIPE-CS SEAMLESS ASTM A 106 (*TCs TO BE VERIFIED BY MAIN CONTRACTOR)	III*			ISMT	AHMADNAGAR	A		UPTO 273 MM OD
					ISMT	BARAMATI	A		UPTO 273 MM OD
					REMI	BHARUCH	A		UPTO 177.8 MM OD
					MAHARASHTRA SEAMLESS	RAIGAD	A		UPTO 500 NB
ITEM WITH MAIN CONTRACTOR / BIS APPROVED SOURCES.									
1	BRANCH PIPE , COUPLING & NOZZLE (SS & GM)	II			BIS APPROVED SOURCES WITH VALID BIS LICENSE				
2	FIRE EXTINGUISHER	II			BIS APPROVED SOURCES WITH VALID BIS LICENSE				
3	WATER MONITOR	II			BIS APPROVED SOURCES WITH VALID BIS LICENSE				
4	PIPES-MS- (BLACK/ GI) AS PER IS:1239 & IS:3589 UPTO 1000 NB	II			(BIS MARKED, MANUFACTURERS WITH VALID BIS LICENSE)				
5	FIRE HOSE	II			BIS APPROVED SOURCES WITH VALID BIS LICENSE				
6	HYDRANT VALVE	II			BIS APPROVED SOURCES WITH VALID BIS LICENSE				

	Project/ परियोजना : EPC PACKAGE FOR GREAT NICOBAR ISLAND GAS POWER PROJECT 108 MW Package/ पैकेज : BOP Supplier/ आपूर्तिकर्ता: Contract No./ अनुबंध सं.:	INDICATIVE LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL क्वालिटी प्लान तथा सब-वेंडर के अनुमोदन सहित मदों की सूची SUB-SYSTEM उप-प्रणाली: BOP SYSTEMS				DOC. NO./ दस्तावेज सं.: REV. NO.: DATE/ तिथि : 26.12.2025 PAGE/ पृष्ठ :			
S. N. क्र.सं.	Item / मद	QP/ Insp. Cat. क्यूपी/ निरी. श्रेणी.	QP No. / क्यूपी. सं.	QP Sub. Schedu le क्यूपी उप.अनु सूचि	Proposed sub-supplier/ प्रस्तावित उप आपूर्तिकर्ता	Place/ स्थान	Sub-suppliers approval status / category उप आपूर्तिकर्ता के अनुमोदन की स्थिति /श्रेणी (NOTE-1)	Sub- supplier Details submissio n schedule/ उप आपूर्तिकर्ता के विवरण प्रस्तुतीकर ण की सूची	Remarks/ टिप्पणी
7	PIPES FOR IDLERS IS 9295	III			BIS APPROVED SOURCES WITH VALID BIS LICENSE				
8	CIO2 GENERATOR	II			MAIN CONTRACTOR APPROVED SOURCES				
9	PIPING FABRICATION	II			MAIN CONTRACTOR APPROVED SOURCES				
10	PUMP-METERING/DOSING	II			MAIN CONTRACTOR APPROVED SOURCES				
11	PUMP - PP- ACID/ ALKALI UNLOADING	II			MAIN CONTRACTOR APPROVED SOURCES				
12	PUMPS-SCREW TYPE	II			MAIN CONTRACTOR APPROVED SOURCES				
13	RUBBER LINING/LAGGING OF TANKS/ VESSELS/ PIPES/ VALVES/FITTINGS/PULLEY	II			MAIN CONTRACTOR APPROVED SOURCES				
14	RO PRESSURE TUBE	II			MAIN CONTRACTOR APPROVED SOURCES				
15	TUBE SETTLER MEDIA	II			MAIN CONTRACTOR APPROVED SOURCES				
16	WRAPPING & COATING MATERIAL -ANTI CORROSIVE TAPE	II			MAIN CONTRACTOR APPROVED SOURCES				
17	GATE- SLUICE/ISOLATION GATE	II			MAIN CONTRACTOR's APPROVED SOURCES				
18	CHLORINE TONER	II			PESO Approved				
19	CHLORINATOR WITH ACCESSORIES LIKE FRP CABINATE, VACCUM/DP RAGULATOR, PRESSURE/VACCUM RELIEF VALVE, FLOW CONTROL VALVE, CHECK/DRAIN VALVE, INJECTOR	II			MAIN CONTRACTOR's APPROVED SOURCES				
20	CHLORINE EVAPORATOR WITH ACCESSORIES LIKE ESPANSION CHAMBER, SAFETY RELIEF VALVE	II			MAIN CONTRACTOR's APPROVED SOURCES				
21	CHLORINE GAS FILTER	II			MAIN CONTRACTOR's APPROVED SOURCES				
22	WINDOW/SPLIT/PACKAGE AC	III			MAIN CONTRACTOR's APPROVED SOURCES				
23	CONDENSING UNIT	III			MAIN CONTRACTOR's APPROVED SOURCES				
24	AHU/AIR WASHER/INSULATION/FILTERS/DUCT/PROPELLER FAN	III			MAIN CONTRACTOR's APPROVED SOURCES				
25	BALANCING VALVE	II			MAIN CONTRACTOR's APPROVED SOURCES				
26	VRF/VRV	II			MAIN CONTRACTOR's APPROVED SOURCES				

<p>A - For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list along with the condition of approval, if any. / इन मदों के लिए प्रस्तावित वेंडर एनटीपीसी को स्वीकार्य है। अनुमोदन की शर्त, यदि कोई हो, के साथ-साथ पत्र "क" में इंगित किया जाए।</p> <p>DR - For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list. एनटीपीसी द्वारा इन मदों की समीक्षा के लिए "विस्तृत ब्योरे की आवश्यकता" होगी। सूची में "DR" पत्र में इंगित किया जाना चाहिए।</p> <p>QP / INSPECTION CATEGORY:</p> <p>CAT-I / श्रेणी- I: For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC. इन मदों के लिए गुणवत्ता योजनाओं को एनटीपीसी द्वारा अनुमोदित किया जाता है और एनटीपीसी द्वारा अंतिम स्वीकृति भौतिक निरीक्षण के दौरान उपलब्ध गवाह के</p> <p>CAT-II / श्रेणी- II: For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP. इन मदों के लिए गुणवत्ता योजनाओं को एनटीपीसी द्वारा अनुमोदित किया जाता</p> <p>CAT-III / श्रेणी-III : For these items Quality control to be exercised as per Main contractor Quality Assurance System. The final acceptance by NTPC shall be on the basis of Certificate of Conformance (COC) by Main Contractor.</p> <p>UNITS/WORKS इकाइयाँ / कार्य: Place of manufacturing/निर्माण का स्थान Place of Main Supplier of multi units/works/बहु- इकाइयाँ / कार्यों के मुख्य सप्लायर का स्थान.</p> <p>FORMAT NO./ प्रारूप सं: QS-01-QAI-P-1B/F1-R0</p> <p style="text-align: right;">Engg. Div. / QA&I</p>	
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		Project/ परियोजना : GNI(GREAT NICOBAR ISLAND) 108MW PROJECT					QUALITY PLAN AND SUB-SUPPLIER APPROVAL क्वालिटी प्लान तथा सब-वेंडर के अनुमोदन सहित मदों की सूची			Doc. No./ दस्तावेज सं.:
		Package/ पैकेज : EPC PACKAGE					प्लान तथा सब-वेंडर के अनुमोदन सहित मदों की सूची			REVISION NO :00
		Supplier/ आपूर्तिकर्ता:					SUB-SYSTEM उप-प्रणाली:			DATE/ तिथि :30.12.2025
		Contract No./ अनुबंध सं.:					ELECTRICAL			
S. No. क्र.सं	Item / मद	QP/ Insp. Cat. क्यूपी/ निरी. श्रेणी.	QP No. / क्यूपी. सं.	QP Sub. Schedu le क्यूपी उप.अनु सूचि	Proposed sub-supplier/ प्रस्तावित उप आपूर्तिकर्ता	Place/ स्थान	Sub-suppliers approval status / category उप आपूर्ति कर्ता के अनुमोद न की स्थिति /श्रेणी	Sub-supplier Details sub sch/ उप आपूर्तिक र्ता के विवरण प्रस्तुतीक रण की सूची	Remarks/ टिप्पणी	
1	Power Transformers	CAT I								
2					ABB	Sweden	A	Up to 765 KV Class		
					ABB	Vadodara	A	Up to 765 KV Class		
					Toshiba	Japan	A	Up to 765 KV Class		
					CG Power & Industrial Solutions Ltd	Mandideep	A	Up to 765 KV class		
					BHEL	Bhopal	A	Up to 400 KV Class		
					Siemens	Mumbai	A	Up to 400 KV Class		
					GE T&D India Limited	Naini	A	Up to 400 KV Class		
					GE T&D India Limited	Vadodara	A	Up to 765 KV Class		
					TELK	Angamally	A	Up to 400 KV Class		
2	Main Alternator	CAT-I			Sub-vendor to be proposed during detailed engineering					Component level item control shall be discussed and finalized during detailed engineering
3	Shunt Reactor	CAT I								
					ABB	Sweden	A	Up to 765 KV Class		
					ABB	Vadodara	A	Up to 765 KV Class		
					Toshiba	Japan	A	Up to 765 KV Class		
					CG Power & Industrial Solutions Ltd	Mandideep	A	Up to 765 KV class		
					BHEL	Bhopal	A	Up to 400 KV Class		
					Siemens	Mumbai	A	Up to 400 KV Class		
					GE T&D India Limited	Vadodara	A	Up to 765 KV Class		
					GE T&D India Limited	Naini	A	Up to 400 KV Class		
4	Auxiliary Oil Filled Transformers	CAT I								
					BHEL	Jhansi	A	Up to 220 KV Class		
					Indotech Transformers	Chennai	A	Up to 16 MVA, 11 KV Class		
					Kanohar	Meerut	A	Upto 16 MVA, 33 KV Class		

					Kirloskar Electric Company Limited	Mysore	A		Up to 16 MVA, 33 KV Class	
					Schneider	Vadodara	A		Up to 50MVA, 132 KV Class	
					Transformers & Rectifiers Ltd.	Ahmedabad	A		Upto 90 MVA, 132 KV Class	
					CG Power & Industrial Solutions Ltd	Malanpur	A		Upto 50MVA, 132kV Class	
					Voltamp	Savli	A		Up to 3.5 MVA, 33 KV Class	
					Shree Abhirami Engineering	Sri Perambudur	A		Upto 2.5MVA, 11kV Class	
					TESLA TRANSFORMERS INDIA LIMITED	Bhopal	A		Upto 9MVA, 11kV Class	
					TELAWNE POWER EQUIPMENT PVT. LTD	MUMBAI	A		up to 33 KV, 12.5 MVA	
5	Dry Type Transformer	CAT I								
					ABB	Savli	A		Up to 8 MVA, 24 KV Class	
					Raychem	Pune	A		Up to 3.5 MVA, 33 KV Class	
					Toshiba	Hyderabad	A		Up to 2.0 MVA, 33 KV Class	
					BHEL	Jhansi	A		Up to 6.3 MVA, 33 KV Class	
					Kirloskar Electric Company Limited	Pune	A		Up to 4.0 MVA, 33 KV Class	
					Voltamp	Savli	A		Up to 3.25 MVA, 33 KV Class	
					Ames Impex	Mehsana Gujrat	A		Up to 1.6 MVA, 11 KV Class	

					Sudhir Power Ltd	Silvassa	A		Up to 1 MVA, 11 KV Class	
					Hammond Power Solutions	Hyderabad	A		Up to 95 KVA, 33KV Class	
					Indcoil Transformers Pvt Ltd	Murbad	A		Up to 600 KVA, 6.6KV Class	
6	OIP/RIP BUSHING									
6.1	OIP/CONDENSER BUSHING	CAT II			BHEL	Bhopal	A		Up to 400 KV class	
					Crompton Greaves Ltd	Nasik	A		Up to 400 KV class	
					Crompton Greaves Ltd	Aurangabad	A		Up to 245 KV Class	
					ABB Ltd.	Vadodara	A		(excluding GT)	
					ABB Switzerland Ltd. MICA FIL Bushings	Switzerland	A		Up to 400 KV class	
					TELK	Angamaly	A		Up to 400 KV class	
					GE T&D India Limited	Hosur	A		Up to 400 KV class	
					Alstom-Passoni Villa	Italy	A		Up to 400 KV class	
					ABB Power Tech.Products	Sweden	A		Up to 400 KV class	
6.2	RIP Bushing	CAT I			Trench	France	A		Up to 400 KV class	
					ABB AB Components	Sweden	A		Up to 420 KV Class	
					ABB Micafil	SwitzerLand	A		Up to 420 KV Class	
					Izolytor (Massa LLC)	Russia	A		Up to 420 KV Class	
					HSP	Germany	A		Up to 420 KV Class	
					Yash High Voltage	Vadodara	A		Up to 145 KV Class	
					Mehru Electricals & Mechanicals Pvt. Ltd (MIM make)	Bhiwadi	A		Up to 420 KV Class	conditions apply
7	INSULATING OIL	CAT I								
					Apar Industries	Rabale/Silvassa	A			
					Power Oil Petroleum Products	Silvassa	A			
					NYNAS NAPTHENICS AB	SWEEDEN / USA	A			
					Kanden Engg Corp Ltd	Japan	A			
					Raj Petro Specialities	Chennai/Silvasa	A			
					Savita Oil Technologies	Mumbai/ Silvasa	A			
					COLUMBIA PETRO CHEMICAL PVT LTD	SILVASSA	A			
8	ON LINE DGA ANALYZER	CAT III								
					GE Kelmen Ltd	UK	A			
					GE GRID SOLUTIONS LTD	LISBURN, UK	A			
					Serveron	USA	A			
					CIC	Vadodara	A		Approval Conditions apply	
9	CAPACITIVE VOLTAGE TRANSFORMER (CVT)	CAT I								
					ABB	VADODARA	A		UP TO 400KV	
					GE T&D	HOSUR	A		UP TO 765 KV	
					BHEL	JHANSI	A		UP TO 400KV	
					MEHRU ELECTRICALS	BHIWADI	A		UP TO 132 KV	
					CGL	NASHIK	A		UP TO 400KV	
10	HT Motor									
10.1	HT MOTOR	CAT - I								
					HYOSUNG	KOREA	A		UPTO 11KV 13.5 MW	

				WEG	BRAZIL	A		UPTO 11KV 2150 KW	
				WEG	hosur	A		UPTO 11KV 14 MW	
				BHEL	BHOPAL	A		RQP	
				HYUNDAI	KOREA	A		UPTO 11KV 17 MW	
				TECO	TAIWAN	A		UPTO 11KV 12 MW	
				TMEIC	JAPAN	A		UPTO 11KV 14 MW	
				CONVERTEAM	FRANCE	A		UPTO 11KV 18 MW (*DOCUMENTS FOR NAME CHANGE TO GE CONVERTEAM SHALL BE SUBMITTED FOR APPROVAL)	
				ABB	VADODARA	A		UPTO 6.6KV 2500 KW 11KV 2000 KW FOR PUMP/ FAN/ COMPRESSOR UPTO 6.6KV 750KW FOR MILL, UPTO 6.6 KV 1300KW FOR CRUSHER WITH SCOOP COUPLING	
				IJLIN	KOREA	A		UPTO 11KV 2900 KW, 6.6KV 2500 KW	
				JYOTI	VADODARA	A		UPTO 6.6 KV 2250 KW EXCEPT CRUSHER & MILL APPLICATION	
				MARATHON	KOLKATA	A		RQP, UPTO 6.6 KV 1300 KW FOR CRUSHER WITH SCOOP COUPLING & 11 KV 1600 KW FOR OTHER APPLICATION EXCEPT CRUSHER & MILL	
				CGL (D5 INDUSTRIAL AREA)	MANDIDEEP	A		UPTO 1650 KW 6.6 KV, 1350 KW 11 KV FOR PUMP, FAN, COMPRESSOR. UPTO 3.3 kv 335 kw WITH FLEXIBLE COUPLING FOR MILL APPLICATION	
				CGL (PLOT-9)	MANDIDEEP	A		UPTO 11 KV 4MW FOR PUMP/FAN/COMPR ESSOR	
				CG ELECTRIC SYSTEM	HUNGARY	A		UPTO 3.3 KV 1100 KW	
				TMEIC	BENGALURU	A		UPTO 11 KV 5200 KW	
11	LT MOTOR	CAT - I							

	Refer Note-7				ABB	FARIDABAD	A*	* SUBJECT TO VERIFICA TION VISIT	UPTO 55KW	
					ABB	BANGALORE	A		UPTO 690V, 475kW	
					JYOTI LTD.	VADODARA	A			
					TIPM	JAPAN	A		UPTO 15 KW (NON FLAME PROOF)	
					HYOSUNG	SOUTH KOREA	A			
					WEG	BRAZIL	A			
					HYUNDAI	SOUTH KOREA	A			
					LHP	SOLAPUR	A		UPTO 400KW FROM B-16 WORKS. UPTO 200KW FROM B-11 WORKS.	
					CGL	AHMEDNAGAR	A		RQP, FOR FLAME PROOF MOTOR	
					TMEIC	JAPAN (NAGASAKHI)	A			
					NGEF	BANGALORE	A		UPTO 15 KW	
					BHARAT BIJLEE	MUMBAI	A		RQP, FOR FLAME PROOF ALSO	
					KEC	BANGALORE/ HUBLI*	A		*UPTO 90KW, RQP, FOR FLAME PROOF ALSO	
					MARATHON	KOLKATA	A		RQP (UPTO 690V & 600 KW) FOR FLAME PROOF ALSO	
					ABB	SWEDEN	A		UPTO 55KW	
					HAVELL	NEEMRANA	A		UP TO 90KW	
					KAWAMATA	JAPAN	A		UP TO 75 KW	
					HEM Industries	DAMAN	A		UP TO 30 KW	
					TIPS	JAPAN	A		UP TO 45KW	
11.1	DC Motor (refer Note-7)	CAT I								
					CGL	AHMEDNAGAR	A			
12	LT Switchgear -Floor mounted Draw out type indoor switchgear Panel (MCC, ACDB / DCDB etc.)	CAT I								
					Schneider (formerly L&T)	Mumbai / Coimbatore/ Ahmednagar	A			
					Schneider	Nasik	A		ACB from Schneider, France	
					Siemens	Kalwa	A		Conditions apply	
					Schneider	Vadodara	A			

				BCH ELECTRIC LIMITED	FARIDABAD	A		ACB from Schneider Electric India	
				PYROTECH ELECTRONICS PVT LTD, UNIT IV	Udaipur	A			
12.1	Numerical Relays	CAT II							
				SEL	Pullman, USA	A			
				GE T&D	Stafford, UK	A		P14X, P34X, P44X, P64X, P74X models	
				GE T&D	Chennai	A		P14X, P24X, P34X, P44X, P64X, P74X models	
				ABB	Finland	A			
				ABB	Baroda	A		For 6XX Series	
				GE Multilin	Zamudio, Vizcaya, Spain/ Markham, Ontario, Canada	A		F-650 only	
				Schneider	Stone- UK , Vassa- Finland	A		PX30, PX40, VAMP 5X and VAMP 2XX models	
				Siemens	Germany	A			
				Siemens	Goa	A		7SX Series only	
				Schneider Electric	Bengaluru	A			
				Schneider Electric	Latvia	A		P3, P5 series, conditions applicable- FAT at Chennai works	
12.2	LV Air Circuit Breaker	CAT II							
				C&S Electric	Noida	A			
				L&T	Mumbai	A			
				GE	Bangalore	A			
				Siemens	Germany	A			
				Schneider	France	A			
12.3	LT CT/PT/CBCT/ Control Transformer	CAT III							
				Kappa	Bangalore	A			
				Southern Electric	Chennai	A			
				Precise	Mumbai	A			
				G&M	Baroda	A		CBCT Only	
				Silkaans	Mumbai	A			
				Ind Coil	Mumbai	A			
				Pragati	Thane	A			
				Prayog	Pune	A			
				AE	Mumbai	A			
				Logicstat	Delhi	A		For control transformer only	
				C&S Electric	Noida	A		For CT only	
				Newtek	Aurangabad	A		For CT/PT/Control transformer	

13	LT Switchgear - Floor mounted Fixed type indoor LT Switchgear Panel (MLDB)	CAT I							
					Switching Circuits	Kolkata	A		
					Hindustan Control & equipment Ltd	Kolkata	A	With fabrication & painting at unit II & MP Electrical Narendrapur	
					Maktel	Vadodara	A	Prior Type Testing	
					Jakson	Greater Noida	A		
					Vidyut Control	Gaziabad	A		
					Adlec Power	Rohad (Jhajjar)	A		
					Conquerent Control System	Manesar	A	Condition apply upto 1250A	
					Control & Schematics	Hyderabad	A		
					Positronics	Vadodara	A		
					Schneider (formerly L&T)	Mumbai / Coimbatore/Ahmednagar	A		
					GE	Bangalore	A		
					Schneider	Nasik	A		
					PYROTECH ELECTRONICS PVT LTD, UNIT IV	Udaipur	A		
					Siemens	Kalwa	A		
					Tricolite	Sahibabad/Manesar	A		
					Schneider	Vadodara	A		
					BCH ELECTRIC LIMITED	FARIDABAD	A	ACB from Schneider Electric India	
					Nitya Electrocontrols	Noida	A		
13.1	LT Switchgear - Wall mounted fixed type indoor / outdoor non-compartmentalized Panel (Lighting panels / AC / DC Fuse boards etc.)Power Panel, Emergency Lighting Panel	CAT II							
					Control Devices	Kolkata	A		
					Jasper	Noida	A		
					Havells	Faridabad	A		
					Novateur Electrical & distribution systems	Murthal	A		
					Avaidd Technovator	Manesar	A		
					Switching Circuits	Kolkata	A		

					Hindustan Control & equipment Ltd	kolkata	A		With fabrication & painting at unit II & MP Electrical Narendrapur	
					Maktel	Vadodara	A			
					Jakson	Greater Noida	A			
					Vidyut Control	Ghaziabad	A			
					Adlec Power	Rohad (Jhajjar)	A			
					Conquerent Control System	Manesar	A		Condition apply upto 1250A	
					Control & Schematics	Hyderabad	A			
					Positronics	Vadodara	A			
					L&T	Mumbai / Coimbatore/ Ahmednagar	A			
					GE	Bangalore	A			
					Schneider	Nasik	A			
					PYROTECH ELECTRONICS PVT LTD, UNIT IV	Udaipur	A			
					Siemens	Kalwa	A			
					Tricolite	Sahibabad/ Manesar	A			
					Nitya Electrocontrols	Noida	A			
					BCH ELECTRIC LIMITED	FARIDABAD	A		ACB from Schneider Electric India	
					Saravana Switchgear	Bengaluru	A			
13.2	LT Switchgear - Floor mounted Fixed type indoor LT Switchgear Panel (MLDB)	CAT I								
					Switching Circuits	Kolkata	A			
					Hindustan Control & equipment Ltd	Kolkata	A		With fabrication & painting at unit II & MP Electrical Narendrapur	
					Maktel	Vadodara	A		Prior Type Testing	
					Jakson	Greater Noida	A			
					Vidyut Control	Ghaziabad	A			
					Adlec Power	Rohad (Jhajjar)	A			
					Conquerent Control System	Manesar	A		Condition apply upto 1250A	
					Control & Schematics	Hyderabad	A			
					Positronics	Vadodara	A			
					Schneider (formerly L&T)	Mumbai / Coimbatore/Ah mednagar	A			
					GE	Bangalore	A			
					Schneider	Nasik	A			
					Pyrotech	Udaipur	A			
					Siemens	Kalwa	A			
					Tricolite	Sahibabad/Mane sar	A			
					Schneider	Vadodara	A			

				BCH ELECTRIC LIMITED	FARIDABAD	A	ACB from Schneider Electric India	
				Nitya Electrocontrols	Noida	A		
14	MV Switchgear Panel	CAT I						
				BHEL	Bhopal	A	Upto 33KV	
				Megawin	Salem	A*	Upto 33KV	*SUBJECT RESOLUTION OF SITE ISSUES
				Schneider Electric India (Formerly L&T)	Ahmednagar	A	Upto 33KV	
				Siemens	Mumbai	A	Upto 33KV	
				ABB	Nasik	A	Upto 33KV	
				Schneider	Vadodara	A	Upto 11KV	
				Schneider (Salt lake works)	Kolkata	A	Upto 11KV	
14.1	Fast Bus Transfer panel along with relay	CAT I						
				AARTECH SOLONICS LIMITED	Parwanoo	A	conditions apply	
				ABB	Vadodara	A	conditions apply	
				SEL	Delhi	A	conditions apply	
15	LT VFD Control Panel	CAT I						
				Powertech	Sonepat	A	Upto 55 KW with following conditions: i) VFD from Schneider-France, upto 415V, 50KW. ii) Enclosure & bought out items shall be from NTPC acceptable makes & iii) Engineering support for integration will be provided by Schneider/ Authorized integrator of Schneider	
				DANFOSS	Oragadam	A	(upto 690V, 1200kW), VFD drives with VFD sourced from Danfoss-Denmark/USA and Panel sourced from Rittal	
				YASAKAWA	Japan	A	VFD from Yasakawa-Japan, Upto 415V, 132KW	
				YASKAWA	BANGALORE	A	UPTO 575kW/690V	

					ROCKWELL AUTOMATION	SAHIBABAD	A		VFD from Rockwell(Allen Bradley)- USA, (Upto 415 V, 600 KW)	
					ABB	BANGALURU	A		VFD from ABB- Bengaluru, Upto 415V, 250 KW	
					ABB	BANGALURU	A		VFD from ABB- Finland, Upto 690V, 1500 KW	
					SIEMENS	NASIK	A		VFD from SIEMENS- Germany, Upto 690V,900KW	
					SEIPL	Navi Mumbai	A		LT VFD upto 575KW, 690V	
					AMTECH	GANDHINAGAR	A		UP TO 75KW RATING	
					VACON	BANGALORE	A		VFD(NXP model) from VACON Finland, upto 400KW,415V and upto 900KW, 690V	
					CGPIS	MANDIDEEP	A		Up to 500 KW, 690V	
15.1	MV VFD Control Panel	CAT I								
					HITACHI HI REL POWER ELECTRONICS PVT. LTD.	SANAND	A		up to 11 KV rating	
					TMEIC INDUSTRIAL SYSTEMS INDIA PRIVATE LIMITED	TUMKUR	A		up to 11 KV rating	
16	Fire sealing system - Type A Material supplier									
		CAT II			3M India	Bangalore	A			
		CAT III*			GE Silicon	USA	A		*WITH MTC	
		CAT III*			Hilti	Germany	A		*WITH MTC	
		CAT III*			DOW Corning	USA	A		*WITH MTC	
16.1	Fire sealing system - Type B Material supplier	CAT II								
					LLOYDS	Delhi	A			
					Signum	Nagpur	A			
					Vijay System Engineers Pvt Ltd	Valsad	A			
16.2	Executing Agency for Fire sealing system	CAT I								
					LLOYDS	Delhi	A			
					Signum	Nagpur	A			
					Vijay System Engineers Pvt Ltd	Valsad	A			
					3M India	Bangalore	A			
17	CURRENT TRANSFORMER	CAT I								
					Mehru Electrical	Bhiwadi	A		UP TO 132 KV	

				GE T&D	Hosur	A	UP TO 765 KV	
				ABB	Vadodara	A	UP TO 400KV	
				CGL	Nasik	A	UP TO 400KV	
				BHEL	Bhopal	A	UP TO 400KV	
				BHEL	Jhansi	A	UP TO 220 KV	
				Vishal Transformer	Meerut	A	UP TO 132 KV	
				Heptacare	Meerut	A	UP TO 33KV	
18	GIS	CAT-I						
				ABB/HITACHI ENERGY INDIA LIMITED	VADODARA	A	UPTO 400kV	
				GE T&D	CHENNAI	A		
				HYOSUNG	S.KOREA	A		
				HYOSUNG T&D INDIA PVT LTD	PUNE	A	UPTO 400kV	
				TOSHIBA TRANSMISSION AND DISTRIBUTION SYSTEMS (India) PVT. LTD.	SANGAREDDY, HYDERABAD	A	UPTO 400kV	
18.1	CIRCUIT BREAKER	CAT I						
				GE T&D	KANCHIPURAM	A	UP TO 765 KV	
				ABB	VADODARA	A	UP TO 400 KV	
				SIEMENS	AURANGABAD	A	UP TO 400 KV	
				BHEL	Hyderabad	A	UP TO 400 KV	
				CGL	NASHIK	A	UP TO 400 KV	
19	ISOLATOR	CAT I						
				GR POWER	HYDERABAD	A	UP TO 400KV	
				HIVELM	CHENNAI	A	UP TO 400KV	
				S&S POWER	PONDICHERRY	A	UP TO 400KV	
				SIEMENS	HYDERABAD	A	UP TO 765 KV	
				ELEKTROLITES	JAIPUR	A	UP TO 33 KV	
				SWITCHGEAR & STRUCTURALS	HYDERABAD	A	UP TO 765 KV	
				Switchgear Manufacturing Company Private Limited	CHITTOOR	A	UPTO 145kV	
20	SURGE ARRESTOR	CAT I						
				CGL	NASIK	A	UP TO 400KV	
				ELEKTROLITES	JAIPUR	A	UP TO 33 KV	
				LAMCO	HYDERABAD	A	UP TO 400KV	
				OBLUM	HYDERABAD	A	UP TO 765 KV	
21	CLAMPS & CONNECTORS & WELDING SLEEVES	CAT I						
				ELCTROMECH TRANSTECH	KOLKATA	A		
				EXALT	MUMBAI	A		
				KLEMMEN ENGG	CHENNAI	A		
				MEGHA ENGG	CHENNAI	A		
				MILIND	MUMBAI	A		
				EMI	MUMBAI	A		
				NOOTAN ENGG	MUMBAI	A		
				TAG CORPORATION	CHENNAI	A		
				ITPL	MUMBAI	A		
				RASHTRA UDYOG	KOLKATA	A		
				Premier Power Products	Chennai	A		
				PEE VEE ENGG	BANGALORE	A		
				LEGION ENERGY	BANGALORE	A		
				Vensun Techno Links (P) Ltd.	Chennai	A		
21.1	ACSR CONDUCTOR	CAT I						
				APAR INDUSTRIES	SILVASSA	A		

				CABCON	KOLKATA	A			
				DIAMOND	VADODARA	A			
				GALAXY	SANGLI	A			
				GUPTA POWER INFRA	BHUBANESWAR	A			
				HIRA CABLES	HIRAKUD	A			
				JSK	SILVASSA	A			
				LUMINO	KOLKATA	A			
				SARAVATHY	BANGALORE	A			
				HIREN ALUMINIUM	SILVASSA	A			
				SMITA	GHAZIABAD	A			
				SASHI CABLES LTD	LUCKNOW	A			
				Mahavir Transmission Limited	DEHRADUN	A			
				TRANSRAIL LIGHTING LIMITED	SILVASSA	A			
				PALRIWAL Industries	RANCHI	A			
				Rajasthan Cables and Conductors Pvt. Ltd.	Jaipur	A			
				LASER POWER & INFRA PVT. LTD.	Howrah	A			
21.2	ALUMINIUM TUBE	CAT I							
				ALOM EXTRUSIONS UNIT-II	BALASORE	A			
				BANCO	VADODARA	A			
				CENTURY EXTRUSION	KOLKATA	A			
				HINDALCO	RENUKOOT	A			
				HINDALCO	ALUPURAM	A			
				JINDAL ALUMINIUM	BANGALORE	A			
				SUDAL	NASIK	A			
22	SUB STATION AUTOMATION SYSTEM '(BCU, GRP, ENERGY METER, NUMERICAL RELAYS, SWITCHYARD PROTECTION)	CAT I							
				GE T&D	CHENNAI	A			
				ABB	PEENYA	A			
				SCHNEIDER	NOIDA	A			
				SIEMENS	KALWA/GOA	A			
				BHEL	BHOPAL	A			
23	AB Tariff energy meter	CAT I							
				SEMS	Udaipur/Solan	A			
				Elster	Mumbai	A			
				L&T	Mysore	A		For Model ER300P With CMS software.	
24	SPV module	CAT I							
				BHEL	Bangalore	A			
				Warree	Surat	A			
				Emmvee	Bangalore	A			
				Vikram Solar	Parganas	A			
				Lanco Solar	Chattisgarh	A			
				Tata Power Solar	Bangalore	A			
				Alpex	Solan	A			

				Synergy	Durgapur	A		
				Photonix	Satara	A		
				HHV Solar	Bangalore	A		
				Waaree Energies Limited	Umbergaon	A	Model-WSMD-545, Power rating: 545W, Type : Monofacial)	
25	Power Conditioning Unit (PCU)	CAT I						
				Schneider	Bangalore	A	Conditions apply	
				ABB	Bangalore	A	Conditions apply	
				Bongfiglioli	Germany	A	Conditions apply	
				Fecon	Germany	A		
				AEG	Bangalore	A	Conditions apply	
				Hitachi-Hirel	Gandhinagar	A	Conditions apply	
				Hitachi-Hirel	Sananad	A	Conditions apply	
				Vacon	Bangalore	A	Conditions apply	
25.1	String Monitoring Box (SMB)	CAT II						
				Trinity Touch	Palwal	A	Conditions apply	
				Hensel	Sriperumbudur	A	Conditions apply	
				AEG	Bangalore	A	Conditions apply	
				Statcon	Pilkhuwa	A	Conditions apply	
				Weidmuller	Spain	A	Conditions apply	
25.2	EHV Cables	CAT I						
				Iljin Electric	South Korea	A	For 132KV & 220 KV only	
				KEC International	Vadodara	A	Upto 220KV	
				KEI Industries	Bhiwadi	A	Upto 132KV , 220KV	
				Phelps Dodge	Bangkok	A	For 132 KV only	
				LS CABLE & SYSTEM LTD	South Korea	A	Up to 400 KV	
				LS CABLE & SYSTEM LTD	BHIWADI	A	Up to 132 KV	
				Universal Cable Ltd.	Satna	A	Upto 132KV only	
26	H.T. CABLE upto 33KV	CAT I						
				Apar Industries	Umbergaon	A	Upto 33kV	
				Gemscab	Bhiwadi	A	Upto 33kV	
				Gupta Power	Kashipur	A	Upto 33kV	
				Havells India Ltd.	Alwar	A	Upto 11kV	
				KEC International	Vadodara	A	Upto 33kV	
				KEI Industries	Bhiwadi	A	Upto 33kV	
				Krishna Electrical Industries Ltd	Gwalior	A	Upto 11kV	
				Polycab Wires Pvt. Ltd	Daman	A	Upto 33kV	
				Tirupati Plastomatics	Jaipur	A	Upto 11kV	
				Torrent Cable Ltd	Nadaid	A	Upto 33kV	
				CMI	Baddi	A	Upto 11kV	
				Universal Cable Ltd.	Satna	A	Upto 33kV	
				Dynamic Cables	Reengus	A	Upto 33kV	

				Paramount Communications	Khushkhhera	A		Upto 33kV	
27	1.1 KV LT Power Cables (Type- XLPE Insulated, PVC sheathed (incl FRLS))	Refer Note-5							
				Advance Cable	Bengaluru	A			
				Apar Industries Ltd	Umbergaon	A			
				Cords Cables	Bhiwadi	A			
				CMI	Baddi	A			
				Delton Cable Ltd	Faridabad	A			
				Dynamic Cables	Jaipur	A			
				Gemscabs Industries	Bhiwadi	A			
				Goyoline Fibres (I) Ltd	Silvassa	A			
				Gupta Power Cables	Khurda	A			
				Havells India Ltd.	Alwar	A			
				KEC International	Silvassa , Mysore	A			
				KEI Industries	Bhiwadi	A			
				Paramount Cable	Khushkhhera	A			
				Polycab Wires Pvt. Ltd	Daman	A			
				Ravin Cables	Pune	A			
				Special Cables	Rudrapur	A			
				Suyog Electricals Ltd	Halol	A			
				Thermocables	Hyderabad	A			
				Tirupati Plastomatics	Jaipur	A			
				Torrent Cable Ltd	Nadiad	A			
				Universal Cable Ltd.	Satna	A			
				Ravi Industries	Sonepat	A			
				Chandresh Cables	Gandhinagar	A		conditions apply	
				Zenium Cables	Valsad	A			
28	LT Control Cable 1.1 KV, Type - PVC (incl FRLS)	Refer Note-5							
				Advance Cable	Bengaluru	A			
				Apar Industries Ltd	Umbergaon	A			
				Cords Cables	Bhiwadi	A			
				CMI	Faridabad	A			
				CMI	Baddi	A			
				Delton Cable Ltd	Faridabad	A			
				Elkay Telelink	Faridabad	A			
				Gemscabs Industries	Bhiwadi	A			
				Goyoline Fibres (I) Ltd	Silvassa	A			
				Gupta Power Cables	Khurda	A			
				Havells India Ltd.	Alwar	A			
				KEC International	Silvassa , Mysore	A			
				KEI Industries	Bhiwadi	A			
				Paramount Cable	Khushkhhera	A			
				Polycab Wires Pvt. Ltd	Daman	A			
				Ravin Cables	Pune	A			

				Special Cables	Rudrapur	A			
				Suyog Electricals Ltd	Halol	A			
				Thermocables	Hyderabad	A			
				Tirupati Plastomatics	Jaipur	A			
				Torrent Cable Ltd	Nadiad	A			
				Universal Cable Ltd.	Satna	A			
				Chandresh Cables	Gandhinagar	A		conditions apply	
				Zenium Cables	Valsad	A			
29	DC Batteries (Ni-Cd type BATTERY)	CAT I							
				HBL- Power System	MEDCHAL	A		Up to 990 An with conditions	
						A		8An to 990An- KPH type	
				Soft India	Bangalore	A		Up to 1365 An- KPM type	
						A		Up to 1550An - KPL type	
30	BATTERY CHARGER (48V/110V/220V)	CAT I							
				Amararaja	Tirupati	A			
				HBL- Power System	Hyderabad	A			
				Chhabi electrical	Jalgaon	A			
				EXIDE	Kolkatta	A			OLD NAME: CHLORIDE POWER
				Statcon	Hapur	A		Up to 220 V, 850 A	
				Dubas	Bangalore	A		Up to 220 V, 800 A	
				VERTIV	PUNE	A		UPTO 220V	
				BANAVATHY POWER PRIVATE SYSTEMS LTD.	Bangalore	A		UPTO 220V,100A	
				SERVILINK ENGINEERS PRIVATE LIMITED	Vadodara	A		UPTO 220V,100A	
30.1	Battery Health Monitoring System	CAT I							
				EXIDE	Kolkatta	A			OLD NAME: CHLORIDE POWER
				HBL- Power System	Hyderabad	A			
				Exide	Kolkata	A			
31	GI CABLE TRAYS AND ACCESSORIES (LADDER & PERFORATED TYPE), fitting & accessories including bends	CAT-II							
				Inar Profiles Ltd	Enkapalli (Vishakhapatnam)	A			
				Vatco	Mumbai	A		Galvanization at Sigma Mumbai	
				Indiana cable trays	Mumbai	A		Galvanization at Karamtara galvanizer- Mumbai	

		Industrial Perforation	Kolkata	A		Galvanized and offered for inspection at Industrial Perforation Pvt Ltd, Ganganagar , Kolkata, WB	
		Ratan Projects	Bagnan	A		In black condition from M/s Ratan Projects, Sankrail	
		India Electric Syndicate	Kolkata	A		Galvanization at BMW Industries/B.P Projects- Howrah	
		Steelite engg.	Mumbai	A			
		Premier Power Products	Howrah	A		Galvanising at Neha Galvaniser- Howrah	
		Indiana Gratings	Pune	A			
		M.J. Engineering	Okhla/ Bhiwadi	A			
		Maheshwari	Ghaziabad	A		Galvanization at NTPC approved Galvaniser.	
		T.R.G	Chennai	A		Galvanization at TM Radhakrishna Chetty & Co-Chennai	
		Amtech	Pune	A		Galvanization at B.G. Shirke - Pune	
		Kannade Anand Udyog	Mumbai	A		- Fabrication at their units: Plot No. 42, Morivali, MIDC, Thane & Plot No.: D-35 Anand Nagar MIDC, Addl. Ambernath , Thane - Galvanization and offer the	
		Rukmani	Raipur	A		Ladder type cable trays only	
		Passive Infra	Hasangarh (Rohtak)	A			
		Unitech Fabricators & Engineers	Howrah/ Hoogly	A			
		Patny System	Hyderabad	A			
		Rabi Engg	Kolkata	A		Galvanizing from NTPC approved sources	
		MKSD Industries	Taloja	A		Galvanization from Encorp Power Trans- Palghar	
		Reliable Sponge	Kalunga	A			
		Pinax Steel	Patna	A			

					Rukmani	Hoogly	A		Galvanization at Rukmani Fab & Gal-Howrah	
					RMG Steels Pvt Ltd	Noida	A		Galvanization at Shivam Engineers and Fabricators, Ghaziabad	conditions apply
					EROS METAL WORKS (P) LTD	Nagpur	A		Galvanization at M/S EROS INFRASTRUCTURE PVT. LTD., HAVING WORKS ADDRESS AS G-97, M.I.D.C. INDUSTRIAL AREA, BUTIBORI, NAGPUR-441103	
31.1	GI FLEXIBLE CABLE TRAY SUPPORT SYSTEM	CAT-II								
					Vatco	Mumbai	A		Galvanising at Sigma Mumbai	
					Inar profiles	Enkapalli	A			
					Industrial perforations	Kolkata	A			
					Premier power products	Howrah	A		Galvanising at Neha Galvaniser- Howrah	
					Steelite engg.	Mumbai	A			
					Indiana gratings	Pune	A		Galvanising at Poona Galvaniser- Pune	
					Amtech	Pune	A		Galvanising at B.G. Shirke- Pune	
					Ratan Projects	Howrah	A		Galvanization at NTPC approved sources	
					Patny Systems	Hyderabad	A			
32	Galvanised Steel Structure(other than Switchyard & Transmission line GI structures)	CAT II								
					Sangam Structural Ltd	Prayagraj	A		Galvanising at NTPC approved sources	
					RS Infraprojects	Ghaziabad	A			
					Anil Steels	Rohtak	A			
					Jamuna Metals	Delhi	A			
					Pioneer Fabricators	Meerut	A			
					Passive Infraprojects	Rohtak	A			
					PAVITRA INDUSTRIES	HYDERABAD	A		GALVANISATION TO BE DONE FROM GURPREET GALVANIZERS HYDERABAD	
					Namdhari Industrial Traderrs Pvt. Ltd.	Ludhiana	A			
					Eros Infrastructures Private Limited	Nagpur	A			
33	IPBD	CAT I								

					BHEL	Rudrapur	A			
					C&S ELECTRIC	Haridwar	A			
34	SPBD	CAT I								
					BHEL	Rudrapur	A			
					C&S	Haridwar	A			
					GODREJ & BOYCE MANUFACTURING COMPANY LTD	Bangalore	A			
					Powergear	Hindupur	A			
					Powergear	Chennai / Bangalore	A			
					KGS Engg.	Chennai	A			
34.1	Air Insulated Non Segregated phase type LT busduct	CAT I								
					BHEL	Rudrapur	A			
					C&S Electric	G.Noida	A			
				LT	C&S Electric	HARIDWAR	A			
					Unilec	Gurgaon	A		Upto 3200 A	
					Stardrive	Chennai	A			
					Spaceage Swgr Ltd	Bawal	A			
					REEP	Chennai	A			
					Enpro	Chennai	A			
					Nitya Electrocontrols	Noida	A			
					PYROTECH ELECTRONICS PVT. LTD.	UDAIPUR	A		UPTO 4000A	
					GODREJ & BOYCE MFG. CO. LIMITED	Bengaluru	A			
34.2	Sandwiched type LT Busduct	CAT I								
					Godrej	Bangalore	A			
					Henikwon	Malaysia	A			
					C&S	HARIDWAR	A			
35	Neutral Grounding Transformer	CAT II								
					Pragati Electrical Pvt. Ltd.	Mumbai	A			
					Bharat Bijlee Ltd.	Navi Mumbai	A			
					Prayog Electrical Ltd.	Pune	A			
					Andrew Yule	Chennai	A			
36	Rectifier Panel For Hydrogen Generation Plant	CAT I								
					RUTTONSHA INTERNATIONAL RECTIFIERS LTD	HALOL, GUJRAT	A			
					Hind Rectifier	MUMBAI/NASIK	A			
37	132 KV cable termination & straight through jointing kits	CAT I								
					Iljin	South Korea	A			
					ABB Kabeldon	Sweden	A			
					Pfisterer AG	Switzerland	A			
					Tyco Electronics Raychem GmbH	Germany	A			

38	Cable Termination kits and straight through jointing kits	CAT II							
					3M Electro & communication	Pune	A	Upto 33KV	
					Raychem	Mumbai	A	Heat shrinkable type upto 33KV	
					TI	Delhi	A	Heat shrinkable type upto 33KV	
39	Lighting Mast with raise & Lower Type Lantern Carriage / Polygonal Poles	CAT-I I							
					Bajaj	Pune	A		
					BP Projects	Kolkata	A		
					Skipper	Howrah	A		
					Transrail Lighting	Silvassa	A		
					AVAIDS TECHNOVATORS	Alwar	A		
					Utkarsh India Limited	Howrah	A		
					Vakrangee Metal & Mineral Pvt. Ltd.	Raipur	A		
39.1	Lighting poles- Tubular/ polygonal	CAT I			Main contractor approved souces having BIS Licensee/ ISI marked with CML Number				
39.2	Lighting fixtures with accessories (LED type)	CAT II							
					Wipro	Pune	A		
					Surya Roshni	Noida	A		
					Bajaj	Mumbai	A		
					Philips	Noida	A		
					Pyrotech Technologies Pvt. Ltd	UDAIPUR	A		
					Mika	Thane	A		
					GOLDWYN LIMITED	NOIDA	A		
39.3	LED Aviation Obstruction Lights	CAT II							
					AVAIDS TECHNOVATORS	GURUGRAM	A	HIGH INTENSITY NON-LED TYPE	
					Instapower	Roorkee	A	Medium and High Intensity	
40	DG SET(ASSMEBLER & TESTING)	CAT I							
					Kohler	Singapore	A	Up to 1500 KVA ,11KV	
					CLLS	Singapore	A	Up to 1250 KVA, 415 V,	
					Powerica	Silvasa	A	Up to 2000 KVA, 415 V & 1500 KVA, 11 KV	
					Sterling Generators Pvt Ltd	Silvasa	A	Up to 415 V 2000 KVA	
					Supernova	Rajpur(Mehsana)	A	Up to 415 V 2000 KVA	
					JAKSON	PHALTAN	A	Up to 415V 1750KVA; 11kV 750kVA	

40.1	ALTERNATOR for DG set	CAT I							
					Kirloskar Electric	Bangalore	A		415 V alternators
					Cummins Generator Technology (Stamford)	U.K	A		415 V & 11 KV alternators
					Leroy Somer	France	A		Up to 11KV alternator 3500 kW
					Marathan	USA	A		Alternators for up to 415 V, 1500 KVA DG SET
					Cummins Generator Technology (Stamford)	Ahmednagar	A		415 V Alternators up to 1600 KVA
					Toyo Denki Power System	Bangalore	A		11 KV, 1500 KVA
					NIDEC	Bangalore	A		415V, 2800 KVA
40.2	DG Set Control panel / Synchronising panel	CAT I							
					L&T	Mumbai / Coimbatore/ Ahmednagar	A		
					GE	Bangalore	A		
					Siemens	Mumbai	A		
					C&S Electric	Noida / HARIDWAR	A		
					Schneider	Nasik	A		
					Unilec	Gurgaon	A		
					Nitya Electrocontrols	Noida	A		
					Switching Circuits	Kolkata	A		
					Tricolite	Sahibabad / Manesar	A		
					Hindustan Control & equipment Ltd	Kolkata	A		With fabrication & painting at unit II & MP Electrical Narendrapur
					Maktel	Vadodara	A		
					Jakson	Greater Noida	A		
					Vidyut Control	Gaziabad	A		
					Adlec Power	Rohad (Jhajjar)	A		
					Pyrotech	Udaipur	A		
					Anand Power Ltd.	Noida	A		
					Positronics	Vadodara	A		
					Control & Schematics	Hyderabad	A		
					Sterling Generators Pvt Ltd	Silvasa	A		
					Supernova	Rajpur	A		
41	CATHODIC PROTECTION SYSTEM	CAT I							
					CONSULTECH	VADODARA	A		
					CATHODIC CONTROL COMPANY PVT LTD	Bengaluru	A		
					Universal Corrosion Prevention India Ltd	Nadia	NOTED		

					Corrosion Technology Services	Mumbai	NOTED		
					Corrtech International Limited	Ahmedabad	NOTED		
Items Identified as Main Contractor approved sources									
MC 1	Continuous Cast Copper Rod	CAT III							
MC 2	Unimpregnated Densified Wood	CAT III							
MC 3	Marshalling Box Components	CAT III							
MC 4	Air Cell	CAT III							
MC 5	Terminal Connector	CAT III							
MC 6	Oil Flow Indicator	CAT III							
MC 7	Pressure Relief Valve	CAT III							
MC 8	Magnetic Oil Level Gauge	CAT III							
MC 9	OTI/WTI (RTD Type)	CAT III							
MC 10	Off-Circuit Tap Changer	CAT III							
MC 11	Cooling Fan & Motor Assembly	CAT III							
MC 12	Silica Gel Breather	CAT III							
MC 13	Bushing Metal Parts	CAT III							
MC 14	Copper Conductor Bus Bar	CAT III							
MC 15	Copper Foil/Sheet for Dry Type Transformer	CAT III							
MC 16	Core cheese assembly for Bus Reactor	CAT III							
MC 17	Core Clamps & OLTC Bracket, Core/Tie Bolt, Rods & Nuts	CAT III							
MC 18	Epoxy Casting Material for Dry Type Transformer	CAT III							
MC 19	Fibre Glass Covered Copper Conductor for Dry Type Transformer	CAT III							
MC 20	Fibre Glass Sheet for Dry Type Transformer	CAT III							
MC 21	Gaskets	CAT III							
MC 22	Hardwares	CAT III							
MC 23	Motor for OLTC	CAT III							
MC 24	Sheet Metal Enclosure for Dry Type Transformer	CAT III							
MC 25	Steel Plate & Pipe	CAT III							
MC 26	Tank Fabrication up to 5 MVA	CAT III							

MC 27	Temperature Surveillance Unit for Dry Type Transformer	CAT III								
MC 28	Valves (for Radiator/Gun Metal/CI valves,etc.)	CAT III								
MC 29	Gas Collecting Device	CAT III								
MC 30	Networking of Numerical Relay	*(with Switch gear MQP)								
MC 31	Paint	CAT III								
MC 32	Copper for Copper Flats & Copper strips/flexibles	CAT III								
MC 33	OIL PURIFYING EQUIPMENT	CAT III								
MC 34	VACUUM PUMP WITH MOTOR	CAT III								
MC 35	ON LINE MOISTURE REMOVAL SYSTEM	CAT III								
MC 36	Oil Tanker (wheel mounted),10 kL capacity	CAT III								
MC 37	POST INSULATOR	CAT II								
MC 38	DISC INSULATOR/ PIN INSULATOR	CAT II								
MC 39	FIBRE OPTIC CABLE	CAT I								
MC 40	EVENT LOGGER	CAT III								
MC 41	GPS TIME SYNCHRONISATION EQUIPMENT	CAT III								
MC 42	RELAY TEST KIT	CAT III								
MC 43	DISTURBANCE RECORDER	CAT III								
MC 44	OPERATIONAL ANALYSER WITH DCRM KIT	CAT III								
MC 45	FOTE	CAT II								
MC 46	OPGW	CAT II								
MC 47	LARGE VIDEO SCREEN (LVS)	CAT III								
MC 48	Porcelain Insulator	CAT III								
MC 49	Lighting & Welding Transformer	CAT III								
MC 50	Industrial /Welding receptacle & boxes	CAT III								
MC 51	MS Rod/GI Strip/Flat and Wire for Earthing & Lightning protection	CAT III								
MC 52	Flexible Conduit	CAT III								

NOTE	L2 LIST OF MAJOR EQUIPMENT (POWER TRANSFORMER)							SOURCES FOR THESE ITEMS SHALL BE FINALIZED DURING DETAILED ENGINEERING AND MQP FINALIZATION	
1	CRGO STEEL	CAT II							
2	TANK FABRICATION	CAT II							
3	CRGO PROCESSORS	CAT II							
4	CONTINUOUSLY TRANSPOSED CONDUCTOR	CAT II							
5	PAPER INSULATED COPPER CONDUCTOR	CAT II							
6	INSULATING PAPER for PICC	CAT III							
7	MOULDED INSULATION COMPONENTS	CAT III							
8	PRE-COMPRESSED BOARDS & INSULATION COMPONENTS	CAT III							
9	OIL PUMP AND MOTOR SET	CAT II							
10	BUCHOLZ RELAY	CAT III							
11	ON LOAD TAP CHANGER	CAT III							
12	OFAF COOLER	CAT III							
13	RADIATORS	CAT II							
14	REGENERATIVE MAINTENANCE FREE BREATHER	CAT III							
15	CMS System	CAT I							
16	CMS PANEL	CAT II							
17	TRANSFORMER TESTING & MAINTENANCE EQUIPMENTS	CAT III							
NOTE	L2 LIST OF BUS DUCTS								
1	Air Pressurisation Equipment	CAT II							
2	Hot Air Blower	CAT II							
3	LAVT Cubicle / NG Cubicle/ Marshalling Box	CAT II							
4	Epoxy Seal off bushing / Insulators	CAT II							

NOTE	L2 LIST OF SWITCH GEAR							SOURCES FOR THESE ITEMS SHALL BE FINALIZED DURING DETAILED ENGINEERING AND MQP FINALIZATION	
1	Numerical Relays	CAT II						SUB-QR CLEARED VENDORS ARE ACCEPTABLE FOR NUMERICAL RELAYS	
2	Silver Plating	CAT III							
3	LV Air Circuit Breaker	CAT I							
4	LT CT/PT/CBCT/ Control Transformer	CAT II							
5	MV Vacuum Type Circuit Breaker	CAT I							
6	MV CT / PT & CBCT	CAT I							
7	MCBs	CAT III							
8	ENERGY METER	CAT III							
9	H.V. Fuse	CAT III							
10	Terminal Blocks (Control)	CAT III							
11	Surge Capacitors	CAT II							

Note - 1 : Vendors to submit project specific documents as per Sub-QR requirements in case the Vendor is approved under collaboration agreement.

Note - 2: Vendors under 'A' are approved and accepted by NTPC with/without conditions in the past. Similar conditions as the case may be for the vendor shall be applicable for this project and tied up in the quality plan.

Note - 3: Main contractor approved sub vendors are acceptable those are evaluated / assessed as per Main contractor Quality Management System for vendor approval. Main contractor to inform the finally selected vendor to NTPC as soon as PO is placed for these items. In case of sub-QR Note-1 is also applicable.

Note - 4 : BOI shall be reviewed and finalised during MQP approval for items/systems where ever applicable.

Note - 5: Category of inspection for LT Cables:

<i>For Total Contract Quantity per Size</i>	<i>Category Of Inspection</i>
For cable total quantity ≤ 2.5 KM	Cat-III - submission of TC & Certificate of Conformance by Main Contractor for the manufacturers having successfully supplied to any NTPC project-site through Corporate contracts for atleast 2 years
For cable total quantity above 2.5 km & up to ≤ 10 km per size/type	Cat-II for the manufacturers having successfully supplied to any NTPC project-site through Corporate contracts for atleast 2 years
For cable total quantity 10 km and above per size/type	Cat-I


Note - 6: Category of inspection for Cable Trays & Cable Tray Flexible Support System:

<i>For Total Contract Quantity per Size</i>	<i>Category of Inspection</i>
For cable total quantity ≤ 2.5 KM	Cat-III - Submission of TC & Certificate of Conformance by Main Contractor for the manufacturers having successfully supplied to any NTPC project-site through Corporate contracts for atleast 2 years
For cable total quantity above 2.5 km & up to ≤ 10 km per size/type	Cat-II for the manufacturers having successfully supplied to any NTPC project-site through Corporate contracts for atleast 2 years
For cable total quantity 10 km and above per size/type	Cat-I

Note - 7:

i) For Motors less than 50 KW: CAT-III. Acceptance of Motor less than 50 KW is based on COC of the Manufacturer and the Main Contractor confirming as follows: "It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & stand plate and tested in accordance with approved drawing /data sheet."

gland plate and tested in accordance with approved drawing / data sheets". ii) For Motors 50 KW and less than 100 KW : CAT- II. Acceptance of Motor is based on NTPC review of Routine Test inspection report as per IS: 12615 / applicable standards duly witnessed by main contractor along with COC of the Manufacturer and the Main Contractor confirming as follows: "It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & gland plate, space heater and tested in accordance with approved drawing /data sheets". iii) For Motors 100 KW & above : CAT- I. AS PER NTPC APPROVED QUALITY PLAN (To be submitted seperately for NTPC review & approval). iv) DC motors (all rating) - Inspection CAT-I				
Note - 8: NTPC approved Galvanizers:				
1. M/s M J Engg, Delhi	7. M/s National Galvanizer, Kolkata	15. M/s Gurpreet Galvanizer, Hyderabad	19. Unitech Fabricators & Galvanizers- Hoogly	
2. M/s A.V. Engg, Kolkata	8. M/s Unistar Galvanizer, Kolkata	14. M/s Sigma, Mumbai	20. Shivam Engineers and Fabricators, Ghaziabad	
3. M/s Inar Profiles, Vishakapatnam	9. M/s B.P. Project. Kolkata	15. M/s Kaunakrishnan Shetty, Chennai		
4. M/s Anand Udyog, Mumbai	10. M/s Bajaj Pune	16. Karamtara Mumbai		
5. M/s Techno Engg, Chandigarh	11. M/s Electrocure Industries, Mumbai	17. Poona Galvanizers Pune		
6. M/S Steelite Engg, Mumbai	12. M/s B.G. Shirke, Pune	18. Neha Galvanizer- Kolkata		
Note - 9: Relevant certificates shall be submitted for NTPC approval. Approval conditions attached to above identified vendors, as applicable shall be adhered to. Note - 10 : Indigenous sub-vendors for Annexure-I items are acceptable subject to meeting the MLC (Minimum Local Content) in line with latest MOP order.				
LEGENDS / संकेतिका SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY /प्रणाली आपूर्तिकर्ता / सब -वेंडर की स्वीकृति की स्थिति की श्रेणी (SHALL BE FILLED BY NTPC एनटीपीसी द्वारा भरा जाएगा) A - For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list along with the condition of approval, if any./ इन मदों के लिए प्रस्तावित वेंडर एनटीपीसी को स्वीकार्य है। अनुमोदन की शर्त, यदि कोई हो, के साथ-साथ पत्र "क" में इंगित किया जाए। DR - For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list. एनटीपीसी द्वारा इन मदों की समीक्षा के लिए "विस्तृत ब्यौरे की आवश्यकता" होगी। सूची में "DR" पत्र में इंगित किया जाना चाहिए। QP/INSPN CATEGORY: क्यूपी / निरीक्षण की श्रेणी: CAT-I / श्रेणी- I: For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC. इन मदों के लिए गुणवत्ता योजनाओं को एनटीपीसी द्वारा अनुमोदित किया जाता है और एनटीपीसी द्वारा अंतिम स्वीकृति भौतिक निरीक्षण के दौरान उपलब्ध गवाह के आधार पर दी जाएगी। CAT-II / श्रेणी- II: For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP. इन मदों के लिए गुणवत्ता योजनाओं को एनटीपीसी द्वारा अनुमोदित किया जाता है। हालाँकि एनटीपीसी द्वारा कोई भौतिक निरीक्षण नहीं किया जाएगा। एनटीपीसी द्वारा अंतिम स्वीकृति अनुमोदित क्यूपी के अनुसार दस्तावेजों की समीक्षा के आधार पर दी जाएगी। CAT-III/ श्रेणी-III : For these items Quality control to be exercised as per Main contractor Quality Assurance System. The final acceptance by NTPC shall be on the basis of Certificate of Conformance (COC) by Main Contractor. UNITS/WORKS इकाईयां / कार्य: Place of manufacturing/ निर्माण का स्थान Place of Main Supplier of multi units/works/बहु- इकाइयों / कार्यों के मुख्य सप्लायर का स्थान. : Control measure of item covered in quality plan of main item.				
Format No./ प्रारूप सं: QS-01-QAI-P-1B/F1-R0			Engg. Div. / QA&I	

		PROJECT : GREAT NICOBAR ISLAND GAS POWER PROJECT 108 MW			LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB VENDOR APPROVAL		REVISION NO :
		PACKAGE : EPC PACKAGE					DATE :
		CONTRACTOR:					SUB SECTION: C&I
		CONTRACT NO : CS-6401-001-2					
Sr No	Item Description	QP Inspection Category	QP No	Proposed Sub Vendor	City / State / Country	SV Approval Status (Note-1)	Approval Conditions / Remarks
1	AAQMS System						
		I		ACOEM Ecotech Industries Pvt Ltd	Pithampur	A	1. So2 ,Nox,CO,CO2 ,Ozone ,PM-10,PM-2.5 & multipoint calibrator will be from Ecotech Australia 2.Metrological sensor from Dynalab 3. Mercury analyser from LOA agreed sources 4.PI refer Note-07
		I		Horiba India Pvt Ltd	Pune	A	1. So2 ,Nox,CO,CO2 ,Ozone & multipoint calibrator will be from Horiba Japan 2.PM-10,PM-2.5 ,TSP will be from Met One USA & metrological sensor from Spectrum USA 3. Mercury analyser from LOA agreed sources
		I		ENVEA India Pvt Ltd (Old Name : Enviroment SA India Pvt. Ltd.)	Mumbai	A	1.Analysers SO2,Nox,CO2 & SPM from Environment SA France, 2-Multipoint Calibrator From envoiroment SA France 3-Metrological Sensor with interface unit from M/s LSI Lastem SRL, Italy
		I		Thermo Fisher Scientific India Pvt. Ltd	Mumbai	A	1) Analysers (Sox,Nox,CO,SPM,RSPM ,Ozone), multi gas calibrator shall be sourced from their principle Thermo Environmental , USA (Division of M/S Thermo fisher Scientific, USA) 2)Metrological sensors shall be sourced from M/S Metone Instruments USA
		I		Chemtrol Engineering Ltd	Goa	A	1. Analysers from M/S Teledyne USA except Mercury analyser . 2.Metrological sensors & SPM analysers from Met one Instruments Inc USA 3.PI refer note-07
2	Acoustic pyrometer System						
		I		Lucent Marcons Pvt Ltd (As a system Integrator of M/S Scientific Environmental Instruments, Inc. (SEI) USA)	Noida	A	1.Boiler watch processor control unit, acoustic sensor (Pizeo/Microphone with prefab cable) , Preamplifier , mapping software & analog output cards shall be from M/S SEI USA . 2. Enclosure ,OWS ,Waveguide ,Transition cone with flange , venturi , Tube box etc shall be from M/S SEI USA approved sources to be tiedup in MQP. 3. PI refer Note-07
		I		Hi-Tech Systems & Services Ltd (As a system Integrator of M/S Bonnenberg + Drescher GmbH, Germany)	Kolkata	A	1.All critical components are to be procured from M/S Bonnenberg + Drescher GmbH, Germany 2.Standard indiginious components like Solenoid valve (Asco make) ,matching flange ,printer & monitor table shall be supplied by M/S Hi- Tech

		II		Scientific Environment Instrument Inc (SEI)	USA	A	1.PCU ,Acoustic sensor ,Preamplifier mapping software shall be from SEI USA . 2. Enclosure ,OWS ,Waveguide ,Tube box etc shall be from SEI approved sources to be tiedup in MQP. 3.PI refer Note-07
		II		Bonnenberg + Drescher GmbH,	Germany	A	
		II		STOCK Equipment Co	USA	A	
3	Addressable Detector (Multisensor , Photo & Heat Detectors Type), Interface units & Manual call points						
		II		Honeywell Life Safety-HIPL	Gurugram	A	Notifier Brand (Detector, Interface Module only)
		II		Schrack	Austria	A	
		II		Autronica	Norway	A	
		II		Edwards	Mexico	A	
		II		Notifier	USA	A	
		II		Sheld Fire safety	UK	A	
		II		Jhonson Controls	USA	A	Simplex Brand
4	Battery for 24VDC charger & UPS						
		Note-4		Hoppecke Batterien GmbH & Co Kg	Germany	A	For Lead Acid- Plante
		Note-4		Exide	Kolkata	A	For Lead Acid- Plante
		Note-4		SAFT India Ltd	Bengaluru	A	For Ni-Cd
		Note-4		HBL Power	Hyderabad	A	For Ni-Cd ,Upto 990AH (H type)
		Note-4		SAFT	France/Sweeden	A	For Ni-Cd
		Note-4		Hoppecke Batterien GmbH & Co Kg	Germany	A	For Ni-Cd
5	Blank Panels / Cabinets						
		III		Pyrotech Electronics Pvt. Ltd	Udaipur	A	
		III		Rittal India Private Ltd	Bengaluru	A	
		III		Hoffman	Bengaluru	A	
		III		BHEL	Bengaluru	A	
		III		BCH ELECTRIC LIMITED	Faridabad	A	
6	Boner tube leak detection system (AGL-6)						
		III		Hi Tech System & services Ltd (System Integrator of Acoustic Monitoring International Inc. USA)	Kolkata	A	1.M/S Acoustic Monitoring International Inc. USA Make system Conditional as per approval letter 01/CQA/9573-102/Hi-tech-AMI dated 11.04.2013 2.PI refer Note-07
		III		Raman Instruments (System Integrator of M/S Procon UK)	Delhi	A	1.M/S Procon UK Make system 2.PI refer Note-07
		III		BHEL Ltd	Trichurapalli	A	
		III		Instrotech (PTY) Ltd	South Africa	A	
		III		Rectuson Co. Ltd	S.Korea	A	
		III		Procon Engineering	UK	A	
		III		Acoustic Monitoring International Inc. (AMI)	USA	A	
7	CCTV System (IP Based)						
		III		Axis	Sweden	A	1-CCTV components will be of Axis communication AB,Sweden make & Video Management Software will be of Milestone Brand. 2.Other BOI items shall be from LOA approved sources & will be tied up during the finalization MQP.
		III		Bosch	Bengaluru	A	1.CCTV components will be of M/S Bosch make, and supplied through M/s Bosch, Bengaluru. 2.Other BOI items shall be from LOA approved sources & will be tied up during the finalization MQP.
		III		Pelco	USA	A	1.CCTV components will be of M/S Pelco, USA make 2.Other BOI items shall be from LOA approved sources & will be tied up during the finalization MQP.

		III		M/s Samridhi Automations Pvt. Ltd (sparsh make)	Haridwar	A	1.CCTV components will be of M/S Samridhi, Haridwar make. 2.Other BOI items shall be from LOA approved sources & will be tied up during the finalization MQP.
7A	CCTV System (IP Based) /System Integrators						
		I		Jonson Control India Pvt Ltd	Mumbai	A	M/S Pelco Make CCTV system
		I		Toshniwal Industrial Pvt Ltd	Ajmer	A	M/S Axis Make CCTV system
		I		L&T TECHNOLOGY SERVICES	Faridabad	A	M/S Samridhi(sparsh) Make CCTV system
		I		Score Information Technologies Limited	Kolkata	A	M/S Bosch Make CCTV system
		I		Netware Computers	Gurugram	A	M/s Samridhi Automations Pvt. Ltd (Sparsh Make) CCTV
8	Control Desk						
		I		Pyrotech Workspace Solutions Pvt Ltd	Udaipur	A	BOI items like Mosaic tiles /Console items shall be as per LOA approved sources
		I		Cosmos Media Products Pvt Ltd	Greater Noida	A	1.BOI items like Mosaic tiles /Console items shall be as per LOA approved sources 2. H block should be from knurr Germany .Solid acrylic surface should be procured from Du Pont/NTPC approved sources 3.Extruded Al profile structure should be procured from Hindalco (With Knurr design)
		I		Adarsha Control system Pvt Ltd	Bengaluru	A	1.BOI items like Mosaic tiles /Console items shall be as per LOA approved sources 2. Acrylic solid surface (ASS) should be procured from Du Pont /NTPC approved sources 3.wood works are to be done by M/S C K Furn Bangaluru
9	Control Valves						
9-A	Control Valves for Aux PRDS system including desuperheater						
		I		Instrumentation Limited	Palakkad (Kerala)	A	Up to A182F92 material with conditions as per approval letter
		I		Koso India Pvt limited	Nasik	A	Up to A182F92 material with conditions as per approval letter
		I		Bomafa Special Valve solutions Pvt Ltd	Ahmedabad	A	Up to A182F92 material with conditions as per approval letter
		I		KSB MIL Controls Ltd	Thrissur (Kerala)	A	As per approval Ref: 02/CQA/SG/Tanda/MIL Dated 30.09.2015
		I		Control Component India PVT Ltd	Sricity (Andhra Pradesh)	A	1.MQP shall be vetted by M/S CCI -USA 2.Sources of major components like casting /forging and actuators shall be tied up during finalization of MQP
		II		Parcol SPA	Italy	A	
		II		Daume	Germany	A	
		II		HOLTER	Germany	A	
9-B	Control Valve for Start Up System						
		I		Control Component India PVT Ltd	Sricity (Andhra Pradesh)	A	1.The critical components of control valve i.e. Disk Stack (Drag technology) shall be sourced from CCI, USA/CCI S. Korea . 2.The positioner from NTPC approved sources & pneumatic actuators are sourced from CCI S.Korea 3.Control valve to be manufactured as per CCI USA design & drawing.
		I		KOSO India Pvt Ltd	Nasik	A	
		I		Emerson Process Management Ltd	Chennai	A	
		I		KSB MIL Controls Ltd	Thrissur (Kerala)	A	As per approval Ref: EOC/QA/2025-26/K3117992/159756 dtd: 22/05/25
		II		Dresser Produits industriels Industriels S.A.S	France	A	
		II		SEMPPELL AG	Germany	A	Up To size 20 Inches & 2500 ANSI Class
		II		Nihon Koso Co Ltd	Japan	A	
		II		HORA	Germany	A	

		II		CCI	S.Korea	A	
		II		Emerson (Fisher)	USA/France/Japan	A	
9-C	Control Valve for BFP Recirculation.						
		I		Control Component India PVT Ltd	Sricity (Andhra Pradesh)	A	1.The critical components of control valve i.e. Disk Stack (Drag technology) shall be sourced from CCI, USA/CCI S. Korea . 2.The positioner from NTPC approved sources & pneumatic actuators are sourced from CCI S.Korea 3.Control valve to be manufactured as per CCI USA design & drawing.
		I		KOSO India Pvt Ltd	Nasik	A	
		I		KSB MIL Controls Ltd	Thrissur (Kerala)	A	Up to 10 Inches & 3400 ANSI class
		II		Dresser Produits industriels Industriels S.A.S	France	A	
		II		Nihon Koso Co Ltd	Japan	A	
		II		CCI	USA	A	
		II		Emerson (Fisher)	USA/France/Japan	A	
9-D	Control valve for feedwater flow Control						
		I		Control Component India PVT Ltd	Sricity (Andhra Pradesh)	A	1.The critical components of control valve i.e. Disk Stack (Drag technology) shall be sourced from CCI, USA/CCI S. Korea . 2.The positioner from NTPC approved sources & pneumatic actuators are sourced from CCI S.Korea 3.Control valve to be manufactured as per CCI USA design & drawing.
		I		Instrumentation Limited	Palakkad (Kerala)	A	feed control valves upto 12 inches and class 3200
		I		KOSO India Pvt Ltd	Nasik	A	
		I		Emerson Process Management Ltd	Chennai	A	Control valve body assembly will be from Nippon Fisher Japan with IBR form III C certificates .
		I		KSB MIL Controls Ltd	Thrissur (Kerala)	A	1.Provision of straight type of brackets for linkage mechanism 2.Factory fitted strainer /diffuser type seat ring . 3.AFR with T connector for pneumatic connection to volume booster
		II		Dresser Produits industriels Industriels S.A.S	France	A	
		II		Nihon Koso Co Ltd	Japan	A	CONDITIONAL
		II		CCI	USA / Austria / S.Korea / Switzerland	A	
		II		Emerson (Fisher)	USA/France/Japan	A	
9-E	Control valves for Soot blower pressure reducing ,SH/ RH Attemperation.						
		I		Control Component India PVT Ltd	Sricity (Andhra Pradesh)	A	1.The critical components of control valve i.e. Disk Stack (Drag technology) shall be sourced from CCI, USA/CCI S. Korea . 2.The positioner from NTPC approved sources & pneumatic actuators are sourced from CCI S.Korea 3.Control valve to be manufactured as per CCI USA design & drawing.
		I		KOSO India Pvt Ltd	Nasik	A	
		I		Emerson Process Management Ltd	Chennai	A	
		I		KSB MIL Controls Ltd	Thrissur (Kerala)	A	
		I		GE Oil & Gas India Pvt Limited	Coimbatore	A	up to 2500 ANSI Class
		I		Flow Serve India Controls Pvt Ltd	Bengaluru	A	
		I		Instrumentation Limited	Palakkad (Kerala)	A	only for SH / RH
		II		Nihon Koso Co Ltd	Japan	A	
		II		Dressor Masoneilan	USA	A	only for SH / RH/ up to 2500 class
		II		Dresser Produits industriels Industriels S.A.S	France	A	
		II		SPX Flow Technology	USA	A	only for SH / RH
		II		Leslie Controls Inc	USA	A	only for SH / RH
		II		Sempell AG (Tyco group)	Germany	A	only for SH / RH
		II		CCI	USA/Sweden /S.Korea	A	
		II		Emerson (Fisher)	USA/France /Japan	A	

9-F	Control valve(Other application)						
		I		Mascot Valves Pvt Ltd	Ahmedabad	A	Up to size 12 inches & 900 ANSI class
		I		Control Component India PVT Ltd	Sricity (Andhra Pradesh)	A	Up to 2500 ANSI class
		I		KOSO India Pvt Ltd	Nasik	A	
		I		KSB MIL Controls Ltd	Thrissur (Kerala)	A	Up to 2500 ANSI class
		I		Emerson Process Management Ltd	Chennai	A	Up to 2500 ANSI class
		I		GE Oil & Gas India Pvt Ltd	Coimbatore	A	Up to size 10 inches & 900 ANSI class /Up to size 24 inches & 600 ANSI class
		I		Flow Serve India Controls Pvt Ltd	Bengaluru	A	Up to size 14 inches & 600 ANSI class
		I		Forbes Marshal Arca Pvt. Ltd.	Pune	A	Up to size 16 inches & 900 ANSI class
		I		Instrumentation Limited	Palakkad (Kerala)	A	Up to 2500 ANSI class
		I		Severn Glocon India Pvt Ltd	Chennai	A	Up to size 14 inches & 300 ANSI class
		I		M/s Unicorn Valves Pvt. Ltd.	Coimbatore	A	Up to size 18 inches & 300 ANSI class
		I		VYTAL controls pvt ltd	ahmedabad	A	control valves for non severe applications
		II		CCI	USA/Sweden /S.Korea	A	
		II		Nihon Koso Co Ltd	Japan	A	
		II		Emerson (Fisher)	USA/France /Japan	A	
		II		Leslie Controls Inc	USA	A	
		II		PARCOL S.P.A	Italy	A	
		II		Dresser Produits industriels Industriels S.A.S	France	A	
		II		HORA	Germany	A	
		II		Wellend & Tuxhorn	Germany	A	
		II		SPX Flow Technology	USA	A	
		I		M/S TECHNIK VALVES PRIVATE LIMITED.	PALGHAR	A	1.Seal steam control valve with actuator upto size 3" and class 600 conditions as per approval note. 2. NOZZLE VALVES along with actuators upto sizes 1 " and class #300 conditions as per approval note
		II		Sempell AG (Tyco group)	Germany	A	
9-G	Control Valve (Ceramic lined)						
		I		Samson Controls Pvt Ltd	Pune	A	1. For M/S Samson Cera Germany make valve Up to 10 inches size & 150 ANSI class 2. BOI shall be tied up at the time of finalisation of MQP
10	DDCMIS						
		I		ABB	Germany	A	
		I		SIEMENS AG	Germany	A	
		I		Emerson Process Management Asia Pacific Pvt Ltd	Singapore	A	
		I		Hitachi nest control system Pvt Ltd	Bengaluru	A	
		I		Honeywell Automation India Ltd	Pune	A	
		I		GE	France	A	
		I		SIEMENS	Gurugram	A	Electronic modules should be procured from M/s Siemens AG, Germany.
		I		BHEL	Bengaluru	A	For MAX DNA System
		I		Yokogawa	Bengaluru	A	
		I		GE Power India Ltd	Noida	A	
		I		Toshiba	Japan	A	
		I		ABB	Bengaluru	A	
		I		M/s Emerson Electric Co. (India) Pvt Ltd.	Nashik	A	1.All assembly, testing and supply must be done by Emerson process management India pvt. Ltd at approved Nashik work address.
11	Dust Emission Monitor						
		III		Durag India Instrumentation Pvt Ltd	Bengaluru	A	1. For Durag Germany Make Extractive Type Dust density analyser 2. Other components shall be as per approval letter CQA/NTPC BARH STPP-I / D-263 / Durag India Instrumentation Pvt Ltd Bengaluru Dated 28.08.2019

		III		Sick India Pvt Ltd	Mumbai	A	1.For SICK AG Make Extractive Type Dust density analyser 2. Other components shall be as per approval letter CQA/NTPC BARH-1/S-907/M/S SICK India Pvt Ltd dated 28.08.2019
		III		ENVEA India Pvt Ltd (Old Name : Enviroment SA India Pvt. Ltd.)	Navi Mumbai	A	1.For ENVEA UK Make Extractive Type Dust density analyser 2. Other components shall be as per approval letter No.: CQA/NTPC BARH-1/ E-335 / M/S Environment SA India Pvt Ltd Dated 16.09.2019
		III		Land Instruments International	UK	A	For In Situ type /Optical Transreceiver type
		III		Codel	UK	A	For In Situ type /Optical Transreceiver type
		III		Durag Industrie Elektronik GmbH & Co KG	Germany	A	For In Situ type /Optical Transreceiver type & Extractive Type
		III		Emerson Process Management	Ireland	A	For In Situ type /Optical Transreceiver type
		III		SICK AG	Germany	A	For In Situ type /Optical Transreceiver type & Extractive Type
		III		ENEVA	UK	A	For Extractive Type Dust density analyser
12	Electrical Actuators						
12-A	Electrical Actuator (With gear box if applicable)						
		II		Antrieb Technik Pvt Ltd	Chennai	A	For low torque applications only
		II		Auma	Bengaluru	A	
		II		Limitorque	Faridabad	A	Model no L120,SMB,LY series, Gear Box T, HBC Series
		II		Rotork	Bengaluru	A	For low torque app (Up to 1000 Nm)
		II		Rotork Controls (India) Private Ltd	Chennai	A	For low torque app (Up to 1000 Nm) & High torque 4000 to 7000 Nm With integral starter for non critical applications
		III		Auma	Germany	A	
		III		Limitorque	USA	A	
		III		Rotork	UK	A	For low torque app (Up to 1000 Nm)
		III		Nippon gear	Japan	A	
		III		Drehmo GMBH	Germany	A	C Matic Series (DMC/DMCR)
12-B	Electrical Actuator- Non-Intrusive (With gear box if applicable)						
		I		Auma India Pvt Ltd	Bengaluru	A	Also acceptable for Field Bus based applicable
		I		Rotork Control	Chennai	A	Non-intrusive Field bus based Electrical actuator upto 610 Nm
		III		Flowserve	USA	A	Also acceptable for Field Bus based applicable
		III		Bernard Controls	France	A	
		II		M/s Enertork Ltd.	South Korea	A	
12-C	Electrical actuator for ID/FD/PA Blade pitch ,IGV &SCOOP						
		III		Harold Beck & Sons Inc	USA	A	
		III		SIPOS Aktronik GmbH	Germany	A	
13	Electronics Transmitter (Pressure , DP and DP based Flow/Level)						
13-A	Electronics Transmitter (Pressure , DP and DP based Flow/Level)						
		III		ABB Ltd	Bengaluru	A	2600T & critical item from ABB Italy/ Their approved source;
		III		Emerson Process Management Ltd	Pune	A	
		III		Siemens Ltd	Thane	A	Model:-SITRANS P
		III		Honeywell Automation India Ltd	Pune	A	
		III		Baldota Control and Equipment Pvt Ltd	Navi Mumbai	A	PT & DPT of LD 301 Series (SMAR)

		III		Yokogawa India Limited	Bengaluru	A	EJA-E 110,430,530 SERIES & all raw material and BOI under knocked down condition (sensor assembly as a single unit) shall be sourced from M/S Yokogawa Japan
		III		M/s Endress + Hauser India Automation Instrument Pvt Ltd	Aurangabad	A	
		III		Emerson (Rosemount)	USA	A	
		III		Yokogawa	Japan	A	
		III		ABB	Germany / Italy	A	2600T & critical item from ABB Italy/ Their approved source;
		III		Siemens	France	A	Sitrans P DSIII Series
		III		Fuji Electric	France	A	FCX -AIII SERIES
		III		Fuji	Japan	A	
14	EQMS						
		I		SWAN	Hyderabad	A	1. Conductivity analyser, pH analyser and Temperature Transmitter will be of M/s ABB, UK make . 2. TSS analyser will be of M/s Daeyoon, South Korea make . 3. Oil in water analyser will be of M/s TriOs, Germany make. 4. Online BOD/COD analyser will be of M/s Shimadzu, Japan make . 5. Flow meter will be of M/s Khrone Marshall, Maharashtra make. 6. Data Aquisition System will be procured from Knowledge Lens, Karnataka.
		I		DNP International Pvt Ltd	Surat	A	1-Horiba make UV series EQMS analyzers & probes for pH, conductivity & TSS measurement from M/s HORIBA Advanced Techno France SAS(HATFR), France. 2-Project specific authorization letter in the name of system Integrator of sample handling system with EQMS analyzers from OEM needs to be submitted for any subsequent project. 3- Applicable QP for inspection to be vetted by OEM(M/s Horiba).
15	Fiber optic cable						
		Note-3		U M Cables Ltd	Silvassa (Daman)	A	
		Note-3		KEC International Ltd	Mysore	A	
		Note-3		Apar Industries Limited	Valsad (Gujrat)	A	
		Note-3		HFCL	Goa	A	
		Note-3		Aksh Fibre	Bhiwadi (Raj)	A	
		Note-3		Finolex Cable Ltd	Goa	A	
		Note-3		Birla Cable Limited	Rewa	A	
		Note-3		R&M	Switzerland	A	
		Note-3		Molex	UK	A	
		Note-3		Coming	USA	A	
16	Fire alarm Panel						
		II		Toshniwal Industrial Pvt Ltd	Ajmer	A	1.M/S Notifier Make Fire alarm Panel 2.PI Refer Note-07
		II		Bosch Security system	Bengaluru	A	1.Detector , Hooter, MCP, Modules, Panel shall be M/s Bosch Make
		II		Notifier	USA	A	
		II		Autronica	Norway	A	
		II		Schrack	Austria	A	
		II		Edwards	Mexico	A	
		II		Shield Fire safety and security Ltd	UK	A	
		II		Jhonson Controls	Mexico	A	Simplex Brand
17	Flame Monitoring System (Scanner)						

		I	Lucent Marcons Pvt Ltd (System Integrator of M/S Forney Corporation USA)	Noida	A	1.Flame detector, amplifier ,light guide fiber optic , smart display programming unit , test kit & simulator will be supplied from M/S Forney Corporation USA 2.Other components like outer carrier ,IDD cable with connector , expander , Y connector with adapter gasket , fastners & signal isolators will be supplied from M/S Forney Corporation USA approved sources . 3.PI Refer Note-7
		I	HI Tech System & services Ltd (System Integrator of BFI Germany)	Kolkata	A	1.For BFI Germany make system 2. PI Refer Note-7
		I	ABSR Engineers Services Pvt. Ltd (System Integrator of BFI Automation (Flaminotec))			1. Flame Scanner Amplifier and testing Kit are source from BFI Germany. 2. Flame Scanner cable is sourced from NTPC approved sub vendor i.e. M/S TEMPESENS
		I	ABB INDIA LTD	BANGALORE	A	ABB make flame scanners which are bieng manufactured in GPV ASIA, Thailand
		II	Durag India Instrumentation Pvt Ltd	Bengaluru	A	For Durag Germany make system
		II	Forney Corporation	USA	A	
		II	BFI	Germany	A	
		II	Durag GmbH	Germany	A	
		II	Emerson (COEN)	USA	A	
		II	BHEL	Trichurapalli	A	
18	Flow nozzle assembly					
		I	WIKA Process Solutions India Pvt Ltd.	Palwal	A	Up to Alloy steel material grade P-92 & other conditions as per approval letter
		I	Minco India Flow Elements Pvt. Ltd.	Goa	A	Up to size 26 Inches for Alloy steel/ Stainless steel pipe SA335 P-11, P -22 and SA 335 P-91 & other conditions as per approval letter
		I	Instrumentation Limited	Palakkad (Kerala)	A	Up to alloy steel grade P-92 subject to qualified WPS & other conditions as per approval letter
		I	Starmech controls (India) Pvt Ltd	Pune	A	Up to alloy steel grade P-92 subject to qualified WPS & other conditions as per approval letter
		II	SEIKO	Czech Republic	A	
		II	WISE Control	S.Korea	A	
		II	Technomatic	Italy	A	
19	Flue Gas Analyser (CO)					
		III	Forbes Marshall Pvt Ltd	Pune	A	For In situ type CO analyser
		III	ICE (Asia) Pvt Ltd	Mumbai	A	For In situ type CO analyser 1. CO analyser from Protea UK 2. Other components like, Mounting Flanges, tubing, fittings ,junction boxes, air purging system , calibration cylinders & cables will be supplied by ICE (Asia) Pvt Ltd 3.PI refer Note-7
		III	Sick India Pvt Ltd	Mumbai	A	For In Situ Type / CO analyser from SICK AG & Other components like ,Protection tube ,Flanges ,tubing ,fittings ,junction boxes, solenoid valves & calibration cylinders will be supplied by M/S Sick India Pvt Ltd .
		III	Emerson Process Management Ltd	Pawane	A	For M/S Emerson Germany/ USA make Analyser
		III	Codel	UK	A	
		III	Land Instruments International	UK	A	
		III	Sick AG	Germany	A	For In Situ Type
		III	Environnement SA	France	A	For Hot Extractive
		III	Fuji Electric	Japan	A	

		III		Servo max Group	UK	A	
		III		Siemens	Germany	A	
20	Flue Gas Analyser (CO2,SO2 and Nox)						
		III		Sick India Pvt Ltd	Mumbai	A	For In Situ Type SO2 analyser 1. Analyser will be from Sick AG Germany 2. Other components like ,Whether proof covers ,flanges ,purge air unit ,junction boxes ,cables ,PC ,remote display ,gas cylinders shall be supplied by M/s Sick India Pvt Ltd
		III		Emerson Process Management Ltd	Pawane	A	For M/s Emerson Germany/ USA make Hot Extractive SO2, NOx Analyser
		III		Envoirement SA	France	A	For Hot Extractive
		III		Fuji Electric	Japan	A	Hot Extractive Type For SO2 & Nox
		III		Siemens	Germany	A	Hot Extractive Type For SO2 & Nox
		III		Yokogawa Electric Corporation	Japan	A	IR-400 Series (Hot Extractive Type For CO2, SO2 & NOx)
		III		Servo max Group	UK	A	Hot Extractive Type For SO2 & Nox
		II		DXG Ltd	KOREA	A	For SO2, NO, NO2
		III		Sick AG	Germany	A	Hot Extractive Type For CO2, SO2 & NOx and In situ type for SO2 analyser
				M/s ABB India Ltd	Bangalore	A	For M/s ABB Germany make Analyser for Hot Extractive Type For SO2 & Nox
21	Flue Gas Analyser O2 Analyser (HT)						
		III		SECO	Chennai	A	
		III		Marathon Monitor	USA	A	
		III		Servo max Group	UK	A	
22	Flue Gas Analyser {O2 Analyser (LT)}						
		III		Sick India Pvt Ltd	Mumbai	A	For In Situ Type 1. Analyser will be from Sick AG Germany 2. Other components like ,Whether proof covers ,flanges ,purge air unit ,junction boxes ,cables ,PC ,remote display ,gas cylinders shall be supplied by M/s Sick India Pvt Ltd
		III		Analysar Instruments Co Pvt Ltd	Kota	A	For In Situ Type 1.Main parts like Sample probe & Analyser will be supplied by M/s Enotec Germany. 2. Other components like auto calibration unit ,probe protector ,enclosure panel & calibration kit will be supplied & integrated M/s AIC kota. 3.PI refer Note-07
		III		Emerson Process Management Ltd	Pune	A	For In Situ Type For M/s Emerson USA make Analyser
		III		ABB	Bengaluru	A	For In Situ Type For M/s ABB UK make Analyser
		III		Yokogawa India	Bengaluru	A	For In Situ Type For M/s Yokogawa Japan make Analyser
		III		Enotech GmbH	Germany	A	For In Situ Type
		III		Ametek	USA	A	For In Situ Type
		III		Yokogawa Electric Corporation	Japan	A	For In Situ Type
		III		Servo max Group	UK	A	For In Situ Type
		III		Sick AG	Germany	A	For In Situ Type
23	Continous Emission Monitoring system (CEMS)						
		I		Horiba India Pvt Ltd	Pune	A	Approval conditions as per approval letter no - CQA/NTPC Mauda-II / H-321 / M/S Horiba India Pvt Ltd Dated 03.10.2019
		I		Yokogawa India Ltd	Bengaluru	A	1. SO2,NOx & CO2 Analyser will be from M/S Yokogawa Electric Corporation Japan . 2.Other Conditional as per approval letter no Ref. No.:-CQA/BARH-1 / Y-023/ M/s Yokogawa India Ltd dated 21.05.2020
		I		Adage Automation Pvt Ltd.	Goa	A	For M/s Siemens Germany make SO2,NOx & CO2 Analysers

		I		Thermo Fisher Scientific India Pvt. Ltd	Pune	A	Approved only for Dilution Extractive Technique 1)Analyser (SO2,NOx,CO,CO2,Mercury), sampling probe ,sample handling system ,umbical cord etc to be supplied from M/S Thermo Fisher USA . 2) Other BOI shall be as per LOA approved sources
		I		Emerson Process Management India Pvt Ltd	Pune	A	For M/s Emerson UK make SO2,NOx & CO2 Analysers other conditions as per approval letter.
		I		Analyser Instruments Co Pvt Ltd	Kota	A	Analysers from Fuji Japan & other BOI shall be as per LOA approved sources .
		I		ENVEA India Pvt Ltd (Old Name : Enviroment SA India Pvt. Ltd.)	Navi Mumbai	A	Hot Extractive Type / 1.Multipoint gas Analyzers MIR-9000 for SO2, NOx,CO2 & CO ,Probe ,Nafyon drier & heater for drier will be of M/S Environment SA France make. 2. Other components shall be as per the approval letter ref no CQA/NTPC Telangana/E-335/M/SEnvoirement SA India dated 12.02.2019
				Axis Analytics India Pvt Ltd	Ahmedabad	A	Analysers from M/s ABB Germany & other BOI shall be as per LOA approved sources .
				Aaxis Nano Technologies Pvt Ltd	Noida	A	Analysers from M/s ABB Germany & other BOI shall be as per LOA approved sources .
24	Furnace Flame viewing system (High Temperature CCTV Components)						
		III		Sertel Electronics Pvt. Ltd.	Chennai	A	Approved for Visible type only
		III		Hi Tech System and Service (System Integrator of M/S Lenox USA)	Kolkata	A	1.M/S Lenox USA Make System 2.PI refer Note-07
		III		Durag India Instrumentation Pvt Ltd	Bengaluru	A	1.Complete Camera Assembly, IRIS Control etc. from Durag Germany 2.Other Component like chiller, vedio monitor, OFC ,Panel from M/S Durag Approved sources
		III		TLT Engg Pvt. Ltd. (System Integrator of M/S Diamond Power USA/ Sweden make system)	Kolkata	A	1.M/S Diamond Power USA/ Sweden make system 2.PI refre Note-07
		III		Toshniwal Industries (System Integrator of M/S Mirion UK make system)	Ajmer	A	1. M/S Mirion UK make system 2.PI refer Note-07
		III		Diamond Power	USA / Sweden	A	
		III		Durag GmbH	Germany	A	D-VTA-201
		III		Lenox	USA	A	
		III		Mirion	UK	A	
		III		Piper GmbH	Germany	A	
		III		Sabota GmbH	Germany	A	
25	H2 Gas Analyser						
		I		ABB India Ltd	Bengaluru	A	M/s ABB Germany /UK Make analyser
		I		Adage Automation Pvt. ltd	Goa	A	1.M/s Siemens, Garmany (Calomat 6) Make analyser 2. PI refer Note-07
		I		Yokogawa India ltd	Bengaluru	A	M/s Yokogawa Japan (Gas Densitybased) Make analyser
		I		SIEMENS	Gurugram	A	M/s Siemens, Garmany (Calomat 6) Make analyser
		III		GE Sensing EMEA	Ireland	A	Conductivity based

		III	ABB	UK	A	
		III	Emerson (Rosemount)	USA	A	
		III	Environment One Corporation	USA	A	Conductivity based
26	HEA ignitor					
		I	Durag India Instrumentation Pvt Ltd	Bengaluru	A	M/S Durag Germany make HEA Ignitor
		I	Hindustan Thermometers	Ambala	A	Conditional as per approval ref no 01/CQA/0270-102 dated 17.09.2012. Spark tip of their own make is also acceptable
		I	Fives combustion System Pvt Ltd	Vadodara	A	
		I	Boiler control Pvt Ltd	Puddukottai (Tamilnadu)	A	Approved for Aux Boiler package only
		I	ABSR Engineers Services Pvt. Ltd (System integrator of TESI, Italy)	New Town, Kolkata	A	
		III	Unison Industries	USA	A	
		III	Durag GmbH	Germany	A	
		III	Ignition system INC	USA	A	
		III	Tesi SPA	Italy	A	
27	High Temp. cable (PTFE/FEP)					
		II	Thermocables	Hyderabad	A	
		II	Tempsens	Udaipur	A	
		II	Habia cables	Sweden	A	
		II	Thermo Electrica BV	Netherland	A	
		II	Lapp cables	Germany	A	
		II	Kerpen cables	Germany	A	
		II	TEW & C	USA	A	
28	Impulse Pipes/Tubes					
		I	Divine Tubes Pvt Ltd	gandhinagar, gujarat	A	Seamless SS Pipes ASTM A 213 TP 316H
		I	MAXIM Tubes co pvt ltd	chattral	A	Seamless SS Pipes ASTM A 213 TP 316H
		I	M/s SHUBHLAXMI METALS AND TUBES PVT LTD	Umbergaon, gujarat	A	Seamless SS Pipes ASTM A 213 TP 316H
		I	M/s VENUS PIPES & TUBES LTD	khutch	A	Seamless SS Pipes ASTM A 213 TP 316H
		II	Maharashtra Seamless	Raigarh	A	For CS Pipes only
		II	Ratnamani Metals and Tubes	Gandhinagar	A	For SS only.
		II	Heavy Metals and Tubes	Gandhinagar	A	For SS & CS only.
		II	ISMT	Ahamadnagar	A	For CS/ AS upto Gr 22 Pipes only
		II	Nippon Steel & Sumitomo Metals corporation	Japan	A	
		II	TPS Tecnitube	Germany	A	
		II	Veluric & Manessmann	Germany	A	
		II	Trouvay and Cauvin	France	A	
		II	Sandvik	Sweden	A	For SS only
		II	REMI Edeltahl Tubulars Ltd	Palghar	A	
29	Instrument Cables (F,G & T/C Cables)					
		Note-2	Goyolene Fibers (India) Pvt Ltd	Silvassa	A	F&G Type Cable
		Note-2	Tempsens Instruments Ind Pvt Ltd	Udaipur	A	
		Note-2	Havells India	Alwar	A	F Type Cable
		Note-2	Paramount Communication Ltd	Khushkhera	A	
		Note-2	Polycab	Daman	A	
		Note-2	Delton	Faridabad	A	
		Note-2	KEI	Bhiwadi (Raj)	A	
		Note-2	Elkey Telelinks	Faridabad	A	
		Note-2	CORDS	Kaharani	A	
		Note-2	CORDS	Bhiwadi	A	
		Note-2	Nicco	Kolkata	A	
		Note-2	Universal Cable	Satna	A	
		Note-2	Thermocables	Hyderabad / Mahbubnagar	A	
		Note-2	Gupta Power Infrastructure Ltd.	Khurdha	A	
		Note-2	CMI	Faridabad	A	
		Note-2	Advance Cables Pvt Ltd	Bengaluru	A	F&G Type Cable
		Note-2	Gemscab Industries Ltd	Bhiwadi (Raj)	A	F&G Type Cable
		Note-2	Apar Industries Limited	Valsad	A	F&G Type Cable
		Note-2	Suyog Electricals Ltd	Halol (Gujrat)	A	
		Note-2	Special Cables Pvt Ltd	Rudrapur	A	
		Note-2	T C Communication	Ghaziabad	A	
		Note-2	TEW & C	USA	A	
		Note-2	Habia cables	Sweden	A	

		Note-2		Kerpen cables	Germany	A	
		Note-2		Lapp cables	Germany	A	
		Note-2		Thermo elecrt Bv	Netherland	A	
		Note-2		M/s Svam infratel pvt ltd	palwal, haryana	A	
30	Intelligent Battery charger 24V DC / DCDB/BHMS						
		II		Chabbi Electricals	Jalgaon	A	Rectifier module, Controller module and Battery Health monitoring system shall be of M/s Vertiv make
		II		Eltek SGS Pvt Ltd	Gurugram	A	
		II		Vertiv Energy Pvt Ltd	Pune	A	
31	Large Video Screen (LED Based)						
		I		Delta India Electronics Pvt Ltd	Gurugram	A	
		I		Barco Electronics system (P) Ltd	Noida	A	
		I		Planner System Inc	USA	A	
32	Level switch- Conductivity type						
		II		Raman Instruments (System integrator of Delta Morbey/ Emerson Mobrey /Solartron - Mobrey)	Navi Mumbai	A	1.M/S Emerson (Morbey) UK system 2.PI refer Note-07
		II		HI Tech System & services Ltd (System Integrator of Levelstate systems Ltd ,UK)	Kolkata	A	1. M/S Levekstate UK System .Vessel from M/s Hi Tech 2.PI refer Note-07
		II		BHEL	Trichurapalli	A	
		III		Emerson -Mobrey (Solartron mobrey)	UK	A	
		III		Levelstate Systems Ltd	UK	A	
		III		Yarway	USA	A	
33	Local Instrument Enclosure/Rack						
		I		Pyrotech Electronics Pvt. Ltd	Udaipur	A	BOI from LOA approved sources
		I		Sajas electrical	Trichurapalli (Tamilnadu)	A	BOI from LOA approved sources
		I		Prammen	Puddukottai (Tamilnadu)	A	BOI from LOA approved sources
		I		Chemin C&I Pvt Limited	Puducherry	A	1- BOI from LOA approved sources 2.Fabrication at M/s LUFT tech India 3- Painting at M/s Supream Coater & Fabricator
34	Master Slave Clock System						
		I		Signals and Systems Pvt. Ltd. (SANDS)	Chennai	A	
		I		Masibus	Gandhinagar	A	
		I		Sertel Electronics Pvt. Ltd.	Chennai	A	
		II		Hopf Elektronik GmbH	Germany	A	
		II		Hathway	USA	A	
		II		Mein Berg	Germany	A	
		II		Moser Baer AG	Switzerland	A	
35	Mercury Analyser						
		I		Analyser Instrument Co. Pvt Ltd (AIC)	Kota	A	1. Mercury Analyzer from PS Analytical UK 2.System integration & supply of components like, Enclosure with AC, calibration cylinders, PC will be done by M/s Analyser Instrument Co. Pvt Ltd (AIC) Kota . 3.PI refer Note-07
		III		ENVEA India Pvt Ltd (Old Name : Enviroment SA India Pvt. Ltd.)	Navi Mumbai	A	1-Mercury analyzer with accessories will be from Mercury instruments GmbH Germany . 2- Other components like, sample line between probe to mercury analyzer will be supplied by M/s Environment SA India Pvt Ltd .

		III	Thermo Fisher Scientific India Pvt Ltd	Pune	A	1. Mercury Analyser shall be from Thermofisher USA 2. Other approval conditions are as per approved letter ref no 01/CQA/9578-001/Thermofisher dated 09/12/2016
		III	Durag India Instrumentation Pvt Ltd	Bengaluru	A	Analyser from M/s Verewa Umwelt Germany
		III	Mercury Instruments GmbH	Germany	A	
		III	SICK AG	Germany	A	
		III	Themofisher	USA	A	
		III	Lumax	Russia	A	For AAQMS System
36	PA System (IP Based)					
		III	BNA Technology Consulting Ltd.	Bengaluru	A	BOI shall be from LOA approved sources.
		III	Armtel	Russia	A	
		III	Zenitel	Norway	A	1.PA system active component , Proprietary item will be Zenitel Norway make 2.Other components & BOI shall be from LOA approved sources
		III	Commend International GMBH	Austria	A	
36A	PA System (IP Based)/System Integrators					note-7
		III	Willstrong Solutions Pvt. Ltd	Greater Noida	A	For M/s Armtel Russia system
		III	Toshniwal Industries Pvt Ltd	Ajmer	A	Approval conditions as per approval letter no Patratu-QA/9585-001-102/VA-Willstrong Dated: 21.12.20
		III	Aishan Technologies Pvt Ltd	Bengaluru	A	For M/s Commend Austria make system
		III	Haritasa Checkmate Electronics Pvt Ltd	Bengaluru	A	For M/s Zenitel Norway make system
		III	Haritasa Checkmate Electronics Pvt Ltd	Bengaluru	A	For M/s Commend Austria make system
		III	Netware Computer Pvt Ltd	New Delhi	A	For M/s Commend Austria make system
		III	M/S L&T Technology Services Limited	Faridabad	A	For M/s Commend Austria make system
		III	M/s Wattn Engineering Pvt. Ltd	Bangalore	A	For M/s Commend Austria make system
		III	M/s Score Information Technologies	Howrah	A	For M/s BNA Technology Consulting Ltd. make
		III	M/s Prolink Engineer	Faridabad	A	For M/s Commend Austria make system
		III	M/s Computer Plaza, Kolkata	Kolkata	A	For M/s Commend Austria make system
37	PLC System					
		I	Emerson Automation solution Intellegent plateforms Pvt Ltd	Bengaluru	A	PLC modules from M/s Emerson USA & BOI shall be from LOA approved sources
		I	ABB India Ltd	Bengaluru	A	
		I	Schneider Electric system india Pvt Ltd	Chennai	A	PLC modules from M/s Schneider France & BOI shall be from LOA approved sources
		I	Rockwell	Sahibabad	A	
		I	Siemens	Nasik	A	
		I	Honeywell	Pune	A	PLC modules from M/s Honeywell ,S.Korea & BOI shall be from LOA approved sources
		I	Schneider Electric India Pvt Ltd	Bengaluru	A	PLC modules from M/s Schneider France & BOI shall be from LOA approved sources
37-A	PLC System Integrators					Note-11 and note-7
		I	Ladder Automation Solution Pvt Ltd	Gurugram	A	For M/s Honeywell make system
		I	Virtual Automation	Mazeedpur Hyderabad	A	For M/s Schneider make system
		I	Cotmac Electronics Pvt Ltd	Pune	A	For M/s SIEMENS make system
		I	Tech-Masters	Hyderabad	A	For M/s Emerson make system
		I	Powertech Switchgear (I) Pvt Ltd	Sonepat	A	For M/s Schneider make system
		I	Unity Industrial Automation Pvt Ltd	Delhi	A	For M/s Rockwell make system
		I	EMCONS	Ranchi	A	For M/s Rockwell make system
		I	Divya Engineers	Chennai	A	For M/s SIEMENS make system
		I	M D Industries	Vadodara	A	For M/s Emerson make system
		I	Velox automation	Surat	A	For M/s SIEMENS make system
		I	Vision Compitel	Kolkata	A	For M/s Emerson make system
		I	Adaptive Engineering Private Limited	Ahmedabad	A	For M/s Schneider make system

		I		Greenwave Solutions Private Limited	Kolkata	A	For M/s Rockwell make system
		I		Dreamz Automation	Ghaziabad	A	For M/s SIEMENS make system
		I		Creative Robotics	Ghaziabad	A	For M/s Honeywell make system
		I		Kruti Techno Engineer Pvt Ltd	Chhapraula (GB Nagar)	A	For M/s SIEMENS make system
		I		EDS Instruments & Systems Pvt Ltd	Chennai	A	For M/s Honeywell make system
		I		Delsys Automation Technologies Pvt Ltd	Chennai	A	For M/s Emerson make system
		I		Hindustan Controls and Equipment Ltd	Kolkata	A	For M/s Emerson make system
		I		Vollkraft Engineering And Consultant (P) Ltd	Kolkata	A	For M/s Emerson make system
		I		SSM Infotech Solutions Pvt Ltd	Surat	A	For M/s Schneider make system
		I		Sun Industrial Automation & Solutions	CHENNAI	A	For M/s Schneider make system
		I		ARTEE FLOW CONTROL PVT LTD	ANKLESHWAR	A	For M/s Honeywell make system
		I		CSS AUTOMATION PVT. LTD	KOLKATA	A	For M/s Emerson make system
		I		ARMAX AUTOMATION PVT LTD	BANGALORE	A	For M/s ABB make system
		I		KAIZEN AUTOMATION	AHEMDABAD	A	For M/s Schneider make system
		I		ELECON PERIPHERALS LIMITED	ANAND	A	For M/s ABB make system
		I		M/s Skytech Infinite Platform Private Limited	Bangalore	A	For M/s Emerson make system
		I		M/S MECGALE AUTOMATION PRIVATE LIMITED	Nagpur	A	For M/s Emerson make system
38	Pneumatic Actuator Regulating (Power Cylinder HAD,CAD SADC & Burner Tilt)						
		I		Instrumentation Limited	Palakkad (Kerala)	A	
		I		Kelton	Cochin (Alleppy)	A	
		I		SMC Corporation India Private Ltd	Noida	A	Up to Bore size 12 inches
		I		IMI Norgren Herion Pvt Ltd	Noida	A	
		I		NELES INDIA PRIVATE LIMITED	Dombivli	A	
		II		Dong Woo Valve Control Co. Ltd	S.Korea	A	
		II		Shin Hwa Engineering Co. Ltd	S.Korea	A	
39	Radar type level transmitter						
		III		Limaco	Russia	A	High Frequency Type
		III		Emerson Process Management Ltd	Pawane	A	For M/s Emerson Singapore make
		III		Endress & Houser	Aurangabad	A	
		III		SIEMENS	Canada	A	
		III		B M Technology	Italy	A	For Non Contact type
		III		Magnetrol	Belgium	A	
		III		ABB	USA	A	K-Tech Brand
		III		Endress & Houser	Germany	A	
		III		Saab Rosemount	Sweden	A	
		III		Emerson Process Management	Singapore	A	Rosemount 3300 series for GW Radar & 5600 Series for Non-Contact type
		III		Endress & Houser	Germany	A	
		III		Vega Grieshaber KG	Germany	A	
		III		EIP ENVIRO LEVEL CONTROLS PVT LTD	NOIDA	A	Non-contact type RADAR LEVEL TRANSMITTER for TTPP-III (2X660 MW) DM Plant,
		III		M/s Vega India Level & Pressure Measurement Pvt. Ltd.,	Fulgaon, Pune	A	Main component like Electronic Unit and housing assembly sourced from M/s Vega, Germany.
40	Short Term Fire Proof cable						
		III		nVent Solutions limited	UK	A	
		III		Wrexham Mineral	UK	A	
		III		KME	Italy	A	
41	SWAS (Sampling Handling System and Dry Panel)						
		I		Emerson Process Management Ltd	Pune	A	Analysers and Other BOI Componets from LOA agreed source
		I		Forbes Marshall	Pune	A	Analysers and Other BOI Componets from LOA agreed source
		I		SEPL	Pune	A	Analysers and Other BOI Componets from LOA agreed source
		I		YOKOGAWA INDIA LTD	Bangalore	A	Analysers and Other BOI Componets from LOA agreed source

42	Water Analyser (Chloride, Conductivity, Dissolved Oxygen,pH, Hydrazine, Concentration , Phosphate, Silica, Seldium,Turbidity, Total Iron, Degassed Cation Conductivity)						
		III		Emerson Process Management Pvt Ltd	Pawane	A	For Conductivity,pH, Dissolved Oxygen, Turbidity
		III		Mettlet Toledo India Pvt Ltd	Vasai	A	For pH Analyser (1. PH analyser from M/S Mettler Toledo GmbH Switzerland 2. Other components like, Housing, Panel mounting kit, Tubing's & easy clean mechanism will be supplied by M/s Mettler Toledo India Pvt Ltd)
		III		Endress Hauser India Pvt. Limited	Mumbai	A	For pH Analyser (1. pH sensor with cable , analyser ,retract & cleaning assembly , electrolyte reservoir (As applicable) will be supplied from Principals of M/S Endress Hauser India Pvt. Limited. 2. Other components like, Flow through assembly shall be supplied from M/S Endress Hauser India Pvt. Limited approved sources.)
		III		Forbes Marshall Pvt Ltd	Pune	A	For Conductivity & pH analyser
		I		METTLER TOLEDO INDIA PVT LTD	Mumbai	A	For Chloride Analyser
		III		Thermo Fisher Scientific	USA	A	For Chloride,Dissolved Oxygen,Hydrazine
		III		ABB	UK	A	For Chloride,Dissolved Oxygen,Hydrazine, Phosphate, Silica,Sodium,Turbidity
		III		Hach	USA	A	tecnik
		III		ABB	USA	A	For Conductivity, pH
		III		Yokogawa	Japan	A	For Conductivity
		III		Hach	Switzerland	A	For Dissolved oxygen, Hydrazine, Silica,Sodium
		III		Yokogawa	Japan	A	For pH
		III		Eutech Instrument PTE Ltd	Singapore	A	For Silica
		III		Orion	USA	A	For Sodium
		III		SWAN Analytische Instrumente AG	Hinwil /Switzerland	A	For pH Analyzer , Conductivity analyser ,Dissolve Oxygen analyser , silica Analyzer , Sodium Analyzer , Hydrazine analyser , Turbidity analyser
43	Temp Transmitter						
43-A	Temp Transmitter						
		III		Endress & Houser	Aurangabad	A	
		III		Emerson Process Management Ltd	Pune	A	For M/s Emerson Singapore make
		III		Yokogawa	Bengaluru	A	Make Yokogawa japan and calibration at Yokogawa Banglore
		III		ABB	Bengaluru	A	For M/s ABB Germany make
		III		WKA Instruments India Pvt Ltd	Pune	A	For M/s WKA Germany make Model no T-32
		III		Honeywell Automation India Ltd	Pune	A	
		III		Yokogawa	Japan	A	
		III		Moore	USA	A	
		III		MG Co, Japan	Japan	A	Model No-B3HU-0
		III		Emerson	U.S.A/Singapore/ Germany	A	
		III		ABB	Germany	A	
		III		Emerson Process Management	Germany	A	
		III		Baldota Control & Equipments Pvt. Limited	Navi Mumbai	A	Temperature Transmitters HART Based - Field Mounted type(Model:TLK-TT305H) and Din rail mounted type(Model:TLK-TT306H-R) only
44	Turbine supervisory Instruments along with vibration analysis system.						
		I		GE	Pune	A	For GE Bently ,USA make system
		I		Meggitt India Pvt Ltd	Bengaluru	A	For Meggitt (Vibrometer) Switzerland make system
		I		Forbes Marshall	Pune	A	For Shinkawa ,Japan make system
		II		GE BENTLY	USA	A	
		II		SHINKAWA	JAPAN	A	
		II		MEGGITT	Switzerland	A	

45	Ultrasonic Type Flow Meter (for Stack)						
		III		Sick India Pvt Ltd	Mumbai	A	For Sick AG Germany make
		III		Sick AG	Germany	A	
		III		Durag	Germany	A	
		III		Teledyne	USA	A	
46	Ultrasonic type level Transmitter						
		III		EIP Enviro	Noida	A	1-Ultrasonic level Tx shall be BM Technology Italy make 2-Required mounting arrangement , Testing, Calibration shall be carried out at M/s EIP Works.
		III		E & H	Aurangabad	A	
		III		Emerson Process Management Ltd	Pawane	A	Complete Intrument Transmitter & Probe to be procured from Mobrey UK , only intergration & configuration at Pawane works
		III		BM Technology	Italy	A	
		III		Siemens Miltronics	Canada	A	
		III		Nivelco Process Control	Hungary	A	
		III		E & H	Germany	A	
		III		HAWK Measurement PTY Ltd	Australia	A	
47	UPS With ACDB						
		Note-5		Vertive Energy Pvt Ltd	Pune	A	Upto 125 KVA for 1 phase and 300 KVA for 3 Phase
		Note-5		Vertive Energy Pvt Ltd	Mumbai	A	Upto 160 KVA
		Note-5		Hitachi Hirel Power Electronics Pvt Ltd	Gandhinagar	A	Upto 200 KVA,
		Note-5		Fuji Electric Consul Neowatt Private Limited	Pune	A	Up to 100 KVA single phase
		Note-5		KELTRON	Trivendrum	A	
		Note-5		Merlin & Gerin	France	A	
		Note-5		Gutor	Switzerland	A	
		Note-5		AEG	Germany	A	
		Note-5		Fuji Electric	Japan	A	
48	Vibration Monitoring System						
		II		Sensonics Technology India	Kundli	A	For Sensonic UK system
		II		BHEL	Bengaluru	A	1. Imported items like Vibration Monitors, Cross Connection Cables, Buffered Output Modules, and Piezoelectric Vibration Sensors, Eddy Current type Proximity Probe, Extension Cable and Signal Conditioner will be procured from Valmet Automation, Finland. 2.Indigenous items like Communication cables, networking components, blank panels, TB, OWS will be procured from NTPC approved sources.
		II		IRD Mechanlysis Ltd	Thane	A	Vibration sensors will be sourced from M/s Hansford UK ,however brand name of IRD and its logo is acceptable with suitable tracebility of M/s Hansford ,UK.
		II		Forbes Marshall Pvt Limited	Pune	A	VMS hardware , Sensors ,extention cables shall be shinkawa Japan make .2. All other BOI shall be from LOA agreed sources
		II		GE	Pune	A	For GE Bentley , USA Make
		II		Rockwell Automation	Sahibabad	A	For Rockwell USA make
		II		SKF	Pune	A	For SKF USA make
		II		Imageneous Engineering Pvt Ltd	Vadodara	A	1-For Meggitt Switzerland make 2- Refer note 7
		II		Shinkawa	Japan	A	
		II		GE	USA	A	Bentley Niveda brand
		II		Meggitt	Switzerland	A	
		II		Sensonic Limited	UK	A	
49	Wireless Solution (Microwave Tower Communication)						
		I		L&T Technology Services (LTTS)	Bengaluru	A	1- Wireless Product (Access Point, Antenna) shall be M/s Cambium UK Make 2- Other Item like Switch, Cat-6 Cable can be supplied from M/s LTTS approved sources meeting technical requirements.
		I		Lotus wireless technologies India Pvt Ltd	Visakhapatnam	A	

		I		Sheetal Wireless Technologies Pvt Ltd	Pune	A	
		III		Proxim Wireless Corporation	USA	A	BOI shall be as per approval letter
50	Perimeter Intrusion Detection System						
		III		Senstar	Canada	A	
51	Radar based Perimeter Surveillance System						
		III		Magos System Ltd	Israel	A	Third Party "Cyber Penetration report " shall be provided along with material TC/COC
52	Thermal Camera (PTZ)						
		III		FLIR Commercial Systems INC	USA	A	

Main Contractor approved sources (Note-12)

MC-1	Access & Controller Software	III					Main Contractor Approved Sources
MC-2	Air Filter Regulator	III					Main Contractor Approved Sources
MC-3	Amonia Analyser	III					Main Contractor Approved Sources
MC-4	Amonia leak detector	III					Main Contractor Approved Sources
MC-5	Anemometer	III					Main Contractor Approved Sources
MC-6	Annunciator	III					Main Contractor Approved Sources
MC-7	ANPR	III					Main Contractor Approved Sources
MC-8	ATB Bolloard	III					Main Contractor Approved Sources
MC-9	Audible alarm device	III					Main Contractor Approved Sources
MC-10	Battery Health Monitoring System	III					Main Contractor Approved Sources
MC-11	Bio Matrix Reader	III					Main Contractor Approved Sources
MC-12	Biofouling/ Deposit Monitor	III					Main Contractor Approved Sources
MC-13	Boom Barrier	III					Main Contractor Approved Sources
MC-14	CameraPoles	III					Main Contractor Approved Sources
MC-15	Card Reader	III					Main Contractor Approved Sources
MC-16	CHAIN LINK FENCE	III					Main Contractor Approved Sources
MC-17	Chlorine Leak detector	III					Main Contractor Approved Sources
MC-18	Coal bunker Level monitor	III					Main Contractor Approved Sources
MC-19	Comd & Control System	III					Main Contractor Approved Sources
MC-20	Compression Fittings(SS)	III					Main Contractor Approved Sources
MC-21	Condensing Pots	III					Main Contractor Approved Sources
MC-22	Conduits /Pipe (GI)	III					Main Contractor Approved Sources
MC-23	Conduits lead coated (Flexible)	III					Main Contractor Approved Sources
MC-24	Copper tubing/Brass connectors	III					Main Contractor Approved Sources
MC-25	Coriolios Type Mass Flow meter	III					Main Contractor Approved Sources
MC-26	Coupling /Interposing Relays	III					Main Contractor Approved Sources
MC-27	Density Indicator	III					Main Contractor Approved Sources
MC-28	Density Meter	III					Main Contractor Approved Sources
MC-29	Desk for OWS/EWS/Printer/Server	III					Main Contractor Approved Sources
MC-30	Dew point sensor/meter (H2)	III					Main Contractor Approved Sources
MC-31	Digital Camera (10 MP) with tripod for photo capture	III			Main Contractor Approved Sources		
MC-32	Digital Indicators	III					Main Contractor Approved Sources
MC-33	Door Frame Metal Detector -DFMD	III					Main Contractor Approved Sources
MC-34	Door sensor	III					Main Contractor Approved Sources
MC-35	Dust Sensor	III					Main Contractor Approved Sources
MC-36	Egress Switch	III					Main Contractor Approved Sources
MC-37	Electric to Pneumatic Converter	III					Main Contractor Approved Sources
MC-38	Electrical Control Panel (UCP/Backup)	III					Main Contractor Approved Sources
MC-39	Electrical Indicating Instruments (Mosaic Compatible)	III			Main Contractor Approved Sources		
MC-40	Electro Magenetic Flow meter	III					Main Contractor Approved Sources
MC-41	EM LOCK	III					Main Contractor Approved Sources
MC-42	Emergency exit / door override switch	III					Main Contractor Approved Sources
MC-43	Emergency Siren /Hooter	III					Main Contractor Approved Sources
MC-44	EPABX equipments	III					Main Contractor Approved Sources
MC-45	Flap barrier	III					Main Contractor Approved Sources
MC-46	Flash Lights for covering perimeter area for clear view from PTZ in night time	III			Main Contractor Approved Sources		
MC-47	Flow Gauge	III					Main Contractor Approved Sources
MC-48	Flow Indicator cum Totaliser	III					Main Contractor Approved Sources
MC-49	Flow Switch	III					Main Contractor Approved Sources

MC-50	FRP Junction Box	III				Main Contractor Approved Sources
MC-51	Furnace exit gas temp probe	III				Main Contractor Approved Sources
MC-52	Furniture for control Room(Chair, Almira, Lock)	III		Main Contractor Approved Sources		
MC-53	Geo fencing	III				Main Contractor Approved Sources
MC-54	GIS (2D) map application	III				Main Contractor Approved Sources
MC-55	Glass Break switch at Emergency Exit	III				Main Contractor Approved Sources
MC-56	GPS Sensor based Vehicle Monitoring system	III		Main Contractor Approved Sources		
MC-57	Graphic Interface Unit	III				Main Contractor Approved Sources
MC-58	Guard tour	III				Main Contractor Approved Sources
MC-59	Half Height Turnstile	III				Main Contractor Approved Sources
MC-60	Hand Held Calibrator	III				Main Contractor Approved Sources
MC-61	Handheld Walkie - Talkie	III				Main Contractor Approved Sources
MC-62	Hart Management System	III				Main Contractor Approved Sources
MC-63	HHMD	III				Main Contractor Approved Sources
MC-64	Humidistat / Thermostat / Gyserstat / Airstat	III		Main Contractor Approved Sources		
MC-65	Impact head type flow element	III				Main Contractor Approved Sources
MC-66	Instant Corrosion Rate Monitor & Portable Corrosion Meter	III		Main Contractor Approved Sources		
MC-67	Instrument Tube Fittings (Air)	III				Main Contractor Approved Sources
MC-68	Instrument Valve	III				Main Contractor Approved Sources
MC-69	IR Detector	III				Main Contractor Approved Sources
MC-70	IR LED based Illuminator	III				Main Contractor Approved Sources
MC-71	Isolator	III				Main Contractor Approved Sources
MC-72	KVM Switch/Matrix KVM Switch	III				Main Contractor Approved Sources
MC-73	LAN-UTP cables	III				Main Contractor Approved Sources
MC-74	Level gauge (Transperent & Reflex, Tubular type)	III		Main Contractor Approved Sources		
MC-75	Level Indicator (Float & Board type)	III				Main Contractor Approved Sources
MC-76	Level Scanner (3 D)for Solid Application	III				Main Contractor Approved Sources
MC-77	Level switch - Float/Displacer Type	III				Main Contractor Approved Sources
MC-78	Level Switch (RF Type)	III				Main Contractor Approved Sources
MC-79	Level switch capacitance type	III				Main Contractor Approved Sources
MC-80	LHS CABLE	III				Main Contractor Approved Sources
MC-81	Limit Switch	III				Main Contractor Approved Sources
MC-82	Long Range RFID Reader	III				Main Contractor Approved Sources
MC-83	Maintenance and Calibration Equipment	III				Main Contractor Approved Sources
MC-84	Mini UPS-Type C configuration	III				Main Contractor Approved Sources
MC-85	Monitors 24 Inch Full HD	III				Main Contractor Approved Sources
MC-86	Mosaic tiles /Console items	III				Main Contractor Approved Sources
MC-87	Network components	III				Main Contractor Approved Sources
MC-88	Network Panel	III				Main Contractor Approved Sources
MC-89	On line carbon in Ash analyser	III				Main Contractor Approved Sources
MC-90	Optical Time Domain Reflector-meter (OTDR) with all accessories	III		Main Contractor Approved Sources		
MC-91	Orifice plate assembly	III				Main Contractor Approved Sources
MC-92	ORP Monitor /Analyser	III				Main Contractor Approved Sources
MC-93	OWS/EWS/Server	III				Main Contractor Approved Sources
MC-94	Panic Button with Audible Alarm	III				Main Contractor Approved Sources
MC-95	Panic button/SOS button supportin SIP protocol	III		Main Contractor Approved Sources		
MC-96	Pitot Tube	III				Main Contractor Approved Sources
MC-97	Postive displacement Type Flow Meter	III				Main Contractor Approved Sources
MC-98	Pr./Vaccum/DP Gauges	III				Main Contractor Approved Sources
MC-99	Press, DP, Vaccum Switch	III				Main Contractor Approved Sources
MC-100	Printer (Dot Matrix/Inkjet / Laser)	III				Main Contractor Approved Sources
MC-101	Psychrometer	III				Main Contractor Approved Sources
MC-102	Pulse jet Controller	III				Main Contractor Approved Sources
MC-103	Pulse Valve	III				Main Contractor Approved Sources
MC-104	Residual Chlorine Analyser	III				Main Contractor Approved Sources
MC-105	Reverse Rotation Indicator	III				Main Contractor Approved Sources
MC-106	RFID based Stickers	III				Main Contractor Approved Sources
MC-107	Rotameter	III				Main Contractor Approved Sources

MC-108	Semaphore Indicators	III				Main Contractor Approved Sources
MC-109	Sight Flow Indicator	III				Main Contractor Approved Sources
MC-110	Sliding Gate	III				Main Contractor Approved Sources
MC-111	Smart Positioner	III				Main Contractor Approved Sources
MC-112	SMS gateway	III				Main Contractor Approved Sources
MC-113	Socket Weld Fittings	III				Main Contractor Approved Sources
MC-114	Solenoid Valve	III				Main Contractor Approved Sources
MC-115	Solid Mass Flow Meter	III				Main Contractor Approved Sources
MC-116	SPIKE BARRIER	III				Main Contractor Approved Sources
MC-117	Static Radio Set	III				Main Contractor Approved Sources
MC-118	Storage Device (SAN/NAS/DAS) of 100 TB each	III		Main Contractor Approved Sources		
MC-119	Synchronising Relay	III				Main Contractor Approved Sources
MC-120	Synchroscope	III				Main Contractor Approved Sources
MC-121	Temperature cum Humidity Indicator	III				Main Contractor Approved Sources
MC-122	Temperature Element(Thermocouple , RTD & Thermowell)	III		Main Contractor Approved Sources		
MC-123	Temperature Gauge(With Thermowell)	III				Main Contractor Approved Sources
MC-124	Temperature Switch	III				Main Contractor Approved Sources
MC-125	Terminal Block (Cage and Clamp type)	III				Main Contractor Approved Sources
MC-126	Touchless biometric recorder	III				Main Contractor Approved Sources
MC-127	Traffic Light	III				Main Contractor Approved Sources
MC-128	Transducer	III				Main Contractor Approved Sources
MC-129	Tube thicknes Meter	III				Main Contractor Approved Sources
MC-130	Turnstile - half height	III				Main Contractor Approved Sources
MC-131	Ultrasonic Type Flow Transmitter	III				Main Contractor Approved Sources
MC-132	UVSS	III				Main Contractor Approved Sources
MC-133	Valve manifolds	III				Main Contractor Approved Sources
MC-134	Voltmeter/ Watterhour Meter	III				Main Contractor Approved Sources
MC-135	X-ray Baggage Scanner	III				Main Contractor Approved Sources

LEGENDS :

1.0 SYSTEM SUPPLIER / SUB SUPPLIER APPROVAL STATUS CATEGORY

A - For those items proposed vendor is acceptable to Customer. To be indicated with letter "A" in the list along with the condition of approval, if any.

2.0 QP INSPECTION CATEGORY :

CAT - I : For those items the Quality Plans are approved by Customer and final acceptance will be on physical inspection witness by Customer

CAT - II : For those items the Quality Plans are approved by Customer. However no physical inspection shall be done by Customer. The final acceptance by Customer shall be on the basis of review of documents.

CAT - III : For these items Quality control to be exercised as per Main contractor Quality Assurance System. The final acceptance by NTPC shall be on the basis of Certificate of Conformance (COC) by Main Contractor.

UNITS / WORKS : Place of manufacturing- Place of main supplier of multi units/works.

3.0 NOTES :

NOTE - 1 : A: Vendors to submit project specific documents as per Sub-QR requirements in case the Vendor is approved under collaboration agreement.

B: In case approved sub vendor is offering product with latest model/series apart from earlier approved, vendors to submit project specific documents as per Sub-QR requirements.

NOTE - 2 : For Instrument cable <= 1 KM inspection category CAT - III, For > 1 KM to <= 10 KM Inspection category CAT - II COC & FOR > 10 KM Inspection category CAT-I

NOTE -3 : For Fiber Optic cable <=10KM inspection category CAT - III & for > 10KM Inspection category CAT-II

NOTE-4 : Batteries for UPS <= 10 KVA and batteries for intelligent battery charger 24 V DC <= 40 Amp inspection category CAT-III & for Batteries for UPS> 10KVA and batteries for intelligent battery charger 24 V DC > 40 Amp rating inspection category CAT-I

NOTE-5 UPS <= 10 KVA rating inspection category CAT-III & for > 10KVA rating inspection category CAT-I

NOTE-6 : No Information available

NOTE - 7 - EMPTY CABINETS, COMPUTERS, SIGNAL ISOLATOR/ MULTIPLIER and TB SHALL ALSO BE ACCEPTABLE FROM OWNER ACCPETED IN QP. IF THE TOTAL INTEGRATED PANEL AND FAT IS CONDUCTED INDEGENEOUSLY
NOTE-8 : For the C & I instrumnts mounted on the skid of the main item or supplied as a integral part of the main item, instrument to be supplied as per proven practice of the manufacturer meeting the Customer technical specification requirement.
NOTE-9- This item is a bought out componenet of main equipments like DDCMIS ,PLC,TSI,CCTV ,PA system etc
NOTE-10- For these controlled items, vendor shall be proposed for owner accpetance with-in the agreed contract schedule of the package
NOTE-11 - Major Bought-Out-Items are to be procured from LOA approved sources & the same shall be finalized during the finalization of Manufacturing Quality Plan . MQP shall be duly vetted by OEM with their project specific authorisation letter .
NOTE-12 : Main contractor apporved sub vendors are acceptable those are evaluated / assesesed as per Main contractor Quality Management System for vendor approval. Main contractor to inform the finaly selected vendor to NTPC as soon as PO is placed for these items. In case of sub-QR Note-1 is also applicable.
Note-13 :The items not covered in the list shall be mutually discussed and agreed for item categorization & sub-vendor control during the detailed Engineering in post award activity.
Note-14 : The items of this list, which are not included during the detailed Engineering of post award activity, shall be ignored for any further action.

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Sl. No. क्र.सं.	Item / मद	QAP/Insp. Cat./ क्यूपी/ निरी. श्रेणी.	Proposed Sub Supplier/ प्रस्तावित उप आपूर्तिकर्ता			Place/ स्थान	Sub-Suppliers Approval Status/ Category/ उप आपूर्तिकर्ता के अनुमोदन की स्थिति /श्रेणी (Refer Note-1)	Remarks/ टिप्पणी
1.	Galvanized Steel Structures (Lattice & Pipe) for Switchyard and Transmission Line	I	Vijay Transmission Ltd			Raipur	A	
			Unitech Power Transmission Ltd			Nagpur	A	
			Associated Power Structures			Vadodara	A	
			R.S. Infraprojects Pvt. Ltd			Surajpur	A	
			New Modern Technomech			Mayurbhanj (Orissa)	A	
			Good Luck Steel Tubes			Sikandrabad	A	
			Unique Structures & Towers Ltd.			Raipur	A	
			Vatco Elec-Power Pvt. Ltd.			Navi Mumbai	A	Galvanising at M/s Sigma Galvaniser, Navi Mumbai
			R.S. Infraprojects Pvt. Ltd			Sikandrabad	A	
			Advance Steel Tube			Sahibabad	A	
			Sangam Structures Ltd.			Allahabad	A	
			Reliable Sponge Pvt Ltd Unit III			Kalunga	A	

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			VSP Enterprises Pvt. Ltd			Sonepat	A	
			Skipper Limited			Unit-I: Jangalpur, Howrah. Unit-II: Uluberia Unit, Howrah. Unit- III: BCTL, Howrah.	A	Prototype inspection at Unit-Bagnan, Howrah
			Rukmani Electrical & Component Pvt. Ltd			Raipur	A	
			Encorp Powertrans Pvt Ltd			Palghar	A	
			Ratan Projects & Engineering Co. Pvt. Ltd.			Howrah	A	
			Eros Infrastructures Pvt. Ltd.			Nagpur	A	
			Telecom Network Solutions			Bulandshahar (UP)	A	
			M/s Unitech Fabricators & Engineers Pvt. Ltd.			Hooghly (WB)	A	For Lattice Structure

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	Contract No./ अनुबंध सं.:		Systems प्रणाली:		Sub System/ उप-प्रणाली:	Civil Works	PAGE/ पृष्ठ:		
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			Richardson & Cruddas (1972) Ltd			Nagpur	A		only
2.	Colour Coated Metal Deck & Cladding/Roofing Sheet (Coil)	I	Tata Steel Limited			Khopoli, Raigarh	A		
			Tata Steel Limited			Sahibabad	A		
			Tata Bluescope Steel Ltd			Jamshedpur	A		AL-ZN coil for cladding
			Arcelormittal Nippon Steel India Limited			Pune	A		
			National Steel & Agro Industries Ltd			Dhar	A		
			JSW Steel Coated Products Ltd			Kalmeshwar (Nagpur)	A		
			JSW Steel Coated Products Ltd			Tarapur, Boisar	A		
			JSW Steel Coated Products Ltd			Vasind, Thane	A		
			JSW Steel Coated Products Ltd			Rajpura (Punjab)	A		
			APL Apollo Building Products Private Limited			Baloda Bazar, Raipur, CG	A		AL-ZN coil for cladding
			Bhushan Power & Steel Ltd			Sambalpur	A		

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						(Odisha)		
3.	Reinforcement Steel	III	SAIL				A	
		III	Tata steel Ltd.				A	
		III	JSW Steel Ltd.				A	
		III	Jindal Steel & Power Ltd. (JSPL)				A	
		III	Rashtriya Ispat Nigam Limited (RINL)				A	
		III	ESL Steel Ltd.				A	
		II	Jai Balaji Industries Ltd.			Unit IV, Durgapur	A	Accepted with Conditions under Inspection Category II
		II	Rungta Mines Ltd.			Chaliyama Steel Plant, Jharkhand	A	
		II	Rashmi Metaliks Ltd.			Kharagpur	A	
4.	Electroforged Grating	II	Indiana Gratings Pvt. Ltd.			Pune	A	
			Kanade Anand Udyog			Thane	A	
			Premier Power Products Ltd.			Howrah	A	
			Bhola Ram Steel Pvt. Ltd.			Patna	A	
			Pinax Steel Industries Pvt. Ltd.			Patna	A	

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			Ankit Electrograting			Raipur	A	
			Ferrotech Structural (India) Private Limited.			Pune	A	
			Ratan Projects & Engineering Co. Pvt. Ltd.			Howrah	A	
			MEET Engineering (for Fabrication) Valmont Structure Pvt. Ltd. (for Galvanising)			Vadodara, Gujarat; Halol, Gujarat	A	
			Vinfab Engineers India Pvt. Ltd. (for Galvanising) Vinfab Gratings (for Fabrication)			Thane	A	
5.	Profilers for Colour Coated Metal Deck & Cladding/ Roofing Sheets	II	Main Contractor Approved Source			-	-	
6.	Foundation Bolts	II	Main Contractor Approved Source			-	-	
7.	Bitumen	III	All Government Refineries			-	-	
8.	PTFE Bearing/Elastomeric Bearing	III	MORTH / RDSO Approved Vendors			-	-	
9.	Cement	III	BIS approved sources having valid BIS Licence			-	-	
10.	CI Pipes	III	BIS approved sources having valid BIS Licence			-	-	
11.	RCC Pipes	III	BIS approved sources having valid BIS Licence			-	-	

	Project/ परियोजना:	GREAT NICOBAR ISLAND	LIST OF ITEMS REQUIRING QUALITY PLAN AND(OR) SUB-SUPPLIER APPROVAL क़्वालिटी प्लान तथा सब-वेंडर के अनुमोदन सहित मदों की सूची				Doc No./ दस्तावेज सं.:	CS-6401-001-2	
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12.	CPVC/UPVC Pipes	III	BIS approved sources having valid BIS Licence			-	-		
13.	PVC Water Stop	III	BIS approved sources having valid BIS Licence			-	-		
14.	Polythene Water Storage Tanks	III	BIS approved sources having valid BIS Licence			-	-		
15.	Ceramic / Vitrified Tiles	III	BIS approved sources having valid BIS Licence			-	-		
16.	Particle Boards, Plywood, MDF	III	BIS approved sources having valid BIS Licence			-	-		
17.	Fire Proof Doors	III	Main Contractor approved sources with valid Prototype Test Report from CBRI/CPRI/Govt. Lab.)			-	-		
18.	Construction Chemicals/ Admixture, Water Proofing Compounds and Grouts	III	Main Contractor Approved Source			-	-		
19.	Paint And Painting System	III	Main Contractor Approved Source			-	-		
20.	High Solid Content Liquid Applied Urethane based Elastomeric Membrane for Water Proofing	III	Main Contractor Approved Source			-	-		
21.	AC Kiosk	III	Main Contractor Approved Source			-	-		

NOTES:

- Note-1: Items for which Sub-QR is envisaged, vendors are accepted subject to Sub-QR Clearance from NTPC Engg.
- Note-2: Items not mentioned in above list shall be discussed and mutually agreed in detail engineering during post award activity.
- Note-3: This vendor list is tied up for this project and package as proposed by (Main Contractor Name).
- Note-4: For the items placed in CAT-III for Civil Works, the review and final acceptance shall be done by NTPC-EIC/FQA based on MTC/Certificate of Conformance (COC) in line with Technical Specifications/FQP.

LEGENDS:

- A For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list along with the condition of approval, if any./ इन मदों के लिए प्रस्तावित वेंडर एनटीपीसी को स्वीकार्य है। अनुमोदन की शर्त, यदि कोई हो, के साथ-साथ पत्र "क" में इंगित किया जाए।
- DR For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list. एनटीपीसी द्वारा इन मदों की समीक्षा के लिए "विस्तृत ब्यौरे की आवश्यकता" होगी। सूची में "DR" पत्र में इंगित किया जाना चाहिए।

QP / INSPECTION CATEGORY:

- CAT-I / श्रेणी- I: For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC. इन मदों के लिए गुणवत्ता योजनाओं को एनटीपीसी द्वारा अनुमोदित किया जाता है और एनटीपीसी द्वारा अंतिम स्वीकृति भौतिक निरीक्षण के दौरान उपलब्ध गवाह के आधार पर दी जाएगी।
- CAT-II / श्रेणी- II: For these items the Quality Plans approved by NTPC. However, no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP. इन मदों के लिए गुणवत्ता योजनाओं को एनटीपीसी द्वारा अनुमोदित किया जाता है। हालाँकि एनटीपीसी द्वारा कोई भौतिक निरीक्षण नहीं किया जाएगा। एनटीपीसी द्वारा अंतिम स्वीकृति अनुमोदित क्यूपी के अनुसार दस्तावेजों की समीक्षा के आधार पर दी जाएगी।
- CAT-III/ श्रेणी-III: For these items Quality control to be exercised as per Main contractor Quality Assurance System. The final acceptance by NTPC shall be on the basis of Certificate of Conformance (COC) by Main Contractor.

UNITS/WORKS/इकाईयां / कार्य:

Place of manufacturing/ निर्माण का स्थान Place of Main Supplier of multi units/works/बहु- इकाइयों / कार्यों के मुख्य सप्लायर का स्थान.