

NTPC Limited

(A Government of India Enterprise)



**PATRATU SUPER THERMAL POWER STATION EXPANSION
PHASE -I (3x800 MW)**

PART - D

ERECTION CONDITIONS OF CONTRACT

SECTION – VI

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

BIDDING DOCUMENT NO.: CS-9585-001-2

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PART - D

ERECTION CONDITIONS OF CONTRACT

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PART - D

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1.00.00 1.01.00 1.02.00	GENERAL <p>The following provisions shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work of this contract which is to be performed at site. The erection requirements and procedures not specified in these documents shall be in accordance with the recommendations of the equipment manufacturer, or as mutually agreed to between the Employer and the Contractor prior to commencement of erection work.</p> <p>The Contractor upon signing of the Contract shall, in addition to a Project Co-ordinator, nominate another responsible officer as his representative at Site suitably designated for the purpose of overall responsibility and co-ordination of the Works to be performed at Site. Such a person shall function from the Site office of the Contractor during the pendency of Contract.</p>		
2.00.00 2.01.00 2.02.00	REGULATION OF LOCAL AUTHORITIES AND STATUTES <p>In addition to the local laws and regulations, the Contractor shall also comply with the Minimum Wages Act and the Payment of Wages Act (both of the Government of India) and the rules made there under in respect of its labour and the labour of its sub-contractors currently employed on or connected with the contract.</p> <p>All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully payable under the provisions of the Indian Boiler Regulations and any other statutory laws and its amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the Employer, shall be to the account of the Employer. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees for such inspection and/or registration shall be borne by the Contractor.</p>		
3.00.00 3.01.00 3.02.00	WELDING OF PRESSURE PARTS AND HIGH PRESSURE PIPING <p>The welding of all pressure parts and high pressure piping shall be in accordance with the following requirements :</p> <p>Qualification of Weld Procedures</p> <p>Only qualified welding procedures as per ASME Section IX shall be used by contractor at site. Procedure qualification records along with WPS shall be submitted to NTPC for review. Welding procedure shall indicate all essential and non-essential parameters as per ASME Section IX. Makes of welding consumables shall be subject to employer's approval.</p> <p>Welder's Qualification</p> <p>Only welders who are qualified in accordance with the latest applicable requirements of the Indian Boiler Regulations, shall be permitted to perform any welding work on the pressure parts and its attachment welding. In addition to such statutory qualification requirements, the welders shall also undergo a satisfactory pre-</p>		
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	<p>production qualification test to be conducted by the Contractor at site as per ASME Sec IX in presence of employer's representative(s), prior to performing work under these specifications. The services of an independent testing laboratory shall be retained by the Contractor to perform welder qualification tests for welders.</p> <p>All the welders carrying out welding at site shall carry an identification badge, which shall indicate the category and the grade of welding for which they have been tested and authorised to carry out welding.</p>			
3.03.00	Records			
	Welders performance shall be monitored regularly and record of their performance shall be maintained by contractor in a manner acceptable to the employer. Contractor shall maintain such records including record of procedure qualification & welder qualification and hand-over to the employer at the end of work.			
3.04.00	MARKING			
	On completion of each welded joint, the welder shall mark his regularly assigned identification mark near the joint. The welder's identification numbers, inspection stamps or code symbol stamps and any other information shall not be directly stamped on any alloy steel piping. In alloy steel piping, all such information shall be stamped on separate marking plate which shall be tack welded on pipe near the weld.			
4.00.00	HEAT TREATMENT			
4.01.00	Pre-heating, post-heating and post-weld stress relief operations of all welds, shall be performed in accordance with the requirements of applicable code. Local post weld stress relieving heat treatments shall be adopted only in cases where it is normally impracticable to subject the entire assembly as such for stress relieving operations. Heating may be by means of electric induction coils or electric resistance coils. Oxy-acetylene flame heating or exothermic chemical heating methods will not be permitted. Complete recording of the temperatures through out the stress relieving cycle of the material and the weld subjected to heat treatment shall be made by means of a potentiometric recorder. Recorders other than those of potentiometric type shall not be used for such temperature recording during stress relieving operations.			
	The contractor & employer's representative, at start and at the end of HT Cycle shall sign the time and temperature charts for heat-treatment.			
4.03.00	After setting up the weld joint for heat treatment operation, the Employer's signature shall be obtained on the strips chart of the recorder prior to starting of heat treatment cycle. The right hand corner of the strip chart at the starting point of the heat treatment cycle shall contain details like the weld number, material, diameter and thickness, method of heating adopted, prescribed ranges of heat treatment temperatures, date of heat treatment, reference to item number of the Field welding Schedule (as specified at clause no 7.00.00- of this chapter) etc.			
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5.00.00	WELD EDGE PREPARATION Preparation at site of weld joint shall be in accordance with details acceptable to the Employer. Wherever possible, machining or automatic flame cutting shall be used for edge preparation. Hand flame cutting will be permitted only where edge preparation otherwise is impractical. All slag shall be removed from cuts and all the hand cuts shall be ground smooth to the satisfaction of the Employer. Flame cutting of alloy steel pipe shall be avoided. Wherever such cutting is done, a 200mm length at the cut face shall be removed by machining. Pneumatic hand tools such as edge preparation, tube cutting machine can be used.		
6.00.00	CLEANING AND SERVICING		
6.01.00	The inside of all tubes, pipes, valves and fittings shall be free from dirt, and loose scales before being erected. All the pipelines shall be thoroughly blown and/or flushed. Each steam and water tubes shall be blown with compressed air and shall be subjected to 'ball test' before erection to ensure that no obstructions exist. A system for recording of all such operations shall be developed and maintained in a manner to ensure that no obstructions are left inside the tubes and no tubes are left uncleaned and untested.		
6.02.00	All valves and valve actuators, and dampers and damper actuators, if any, shall be thoroughly cleaned and serviced prior to pre-commissioning tests and/or Initial Operations of the plant. A system for recording of such servicing operation shall be developed and maintained in a manner acceptable to the Employer and to ensure that no valves or dampers including their actuators are left unserviced.		
6.03.00	All interior surfaces of the turbine shall be thoroughly cleaned prior to boxing - up to remove all traces of oil preservations.		
7.00.00	FIELD WELDING SCHEDULE The Contractor shall submit to the Employer, a certified and complete field welding schedule for all the field welding activities to be carried out in respect of the pressure parts involved in the equipment furnished and erected by him, at least 90 days prior to the scheduled start of erection work at site. Such schedule will be strictly followed by the Contractor during the process of erection. The above field-welding schedule to be issued by the Contractor shall contain the following: <ul style="list-style-type: none"> (a.) Drawing No (s) (b.) Location of the weld (c.) Size of the weld (outside diameter and thickness) (d.) Type of joints (e.) Material specifications (f.) Size of fillet on backing ring, when the type of joint is with backing ring (g.) Electrode/ filler metal specifications 		
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	<div>(h.) Number of welds per unit</div> <div>(i.) Quantity of filler metal per weld</div> <div>(j.) Indication of required Non-destructive Examination (NDE) for each weld</div> <div>(k.) Pre-heat temperatures for welding</div> <div>(l.) Process of welding</div> <div>(m.) Post-welding heat treatment temperature ranges, duration, under as specified at clause no 4.00.00 of this chapter entitled "Heat Treatment".</div> <div>(n.) Qualification details of weld procedures to be adopted as specified at clause no 3.01.00 of this chapter entitled 'Qualification of Weld Procedures'.</div>			
8.00.00	SITE RUN MISCELLANEOUS PIPING <p>Sketches or diagrams of the proposed routings of all piping, not already indicated and routed on the shop drawings which were reviewed by the Employer, shall be submitted to the Employer for review, Employer's acceptance of such site routings shall be obtained before the piping is erected. All these site run piping shall be installed in such a manner as to present an orderly and neat installation. They shall be located as to avoid obstruction of access and passages. Valves, instruments or any other special items shall be located convenient for operation by the operating personnel. Pipe runs shall be plumb or level except where pitch for drainage is required. Pipe runs that are not parallel to the building structure, walls or column rows shall be avoided so that deflection of pipes between hangers does not exceed 6 mm. No miscellaneous pipe shall be routed and installed above or adjacent to electrical equipment.</p>			
9.00.00	THERMAL EXPANSIONS <p>All piping installation shall be such that no excessive or destructive expansion forces exist either in the cold condition or under condition of maximum temperature. All bends, expansion joints and any other special fittings, necessary to provide proper expansion, shall be incorporated. During installation of expansion joints and anchors, care must be taken to make sure that full design movement is available at all times for maximum to minimum temperature and vice-versa.</p>			
10.00.00	PIPING SUPPORTS			
10.01.00	Hangers, supports and anchors shall be installed as required to obtain a safe, reliable and complete pipe installation. All supports shall be properly levelled and anchored when installed. The anchors shall be so placed that thermal expansion will be absorbed by bends without subjecting the valves or equipment to excessive strains.			
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10.02.00	<p>The hanger assemblies shall not be used for the attachment of rigging to hoist the pipe into place. Other means shall be used to securely hold the pipe in place till the pipe support is completely assembled and attached to the pipe and building structures and spring support is set to accommodate the pipe way. All temporary rigging shall be removed in such a way that the pipe support is not subjected to any sudden load. All piping, having variable spring type supports, shall be held securely in place by temporary means during the hydraulic test of pipe system. Constant support type spring hangers used during hydraulic test shall be pinned or blocked solid during the test. After complete installation and insulation of the piping and filling of the piping with its normal operating medium, the pipe support springs shall be adjusted to the cold positions. If necessary, the spring support shall be re-adjusted to the hot positions after the line has been placed for service at its normal maximum operating temperature conditions. Electric arc welding only shall be used to weld all pipe supports to structural steel members that form part of the building supporting structure. The structural beams shall not be heated more than necessary during welding of supports and such welds shall run parallel to the axis of the span. All lugs or any other attachments welded to the piping shall be of the same material as the pipe.</p>	
11.00.00	PRESSURE TESTING	
11.01.00	On completion of erection of pressure parts, a hydraulic test in accordance with the requirements of the Indian Boiler Regulations shall be performed by the Contractor.	
11.02.00	<p>All the valves, high pressure pipes and inter-connected pipes connecting the pressure parts shall be tested along with pressure parts. All blank flanges or any removable plugs required for openings not closed by the valves, and piping provided, shall be furnished by the Contractor. The pressurization equipment including water piping from the supply, needed for the above test shall also be furnished by the Contractor. Any defects noticed during the testing are to be rectified and the unit re-tested. If any welding is done on the pressure parts after the Hydraulic test, the Hydraulic test for that portion of pressure parts shall be repeated.</p>	
11.03.00	Thy hydraulic test shall be considered successful only on certification to that effect by the concerned inspecting Authority as per the provisions of the Indian Boiler Regulations and the Employer.	
12.00.00	THERMOWELLS AND FLOW NOZZLES	
12.01.00	All the thermowells and flow nozzles in the equipment furnished under the technical specifications shall be installed as a part of this work.	
12.02.00	<p>All thermowell connections incorporated in the steam service shall be plugged during the pressure testing and the blow out of steam piping systems. Upon completion of the blow out operation, all thermowells shall be installed and seam welded. Similarly, all flow nozzles in the steam lines shall also be installed only on completion of steam blowing operations unless otherwise agreed to by the Employer, depending upon the sequence of cleaning and purging operations to be adopted by the Contractor at the field.</p>	
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13.00.00	<p>INSULATION, LAGGING AND CLADDING</p> <p>The provision of insulation, lagging and cladding of the various equipments and portion of the equipment covered under the Contract, shall be furnished by the Contractor as specified elsewhere or agree to separately in writing. Welds required for holding insulation on pressure parts shall be carried out by IBR qualified welder.</p>		
13.01.00	<p>Piping, Pipe Fittings & Valves</p> <p>All piping insulation and metal cladding furnished with the equipment to be erected shall be applied as specified herein.</p>		
13.01.01	<p>Piping</p> <p>The insulation on piping shall be applied using wire loops on 150mm centres. These wire loops shall be thoroughly embedded into the outer insulation surface and all cracks, voids and depressions shall be filled with insulating cement suitable for the piping temperature so as to form a smooth base for application of cladding. The wires used for piping insulation shall be of 16 SWG. The surface shall be smooth and uniform before applying the outer covering . All piping insulation ends shall be terminated at a sufficient distance from flanges to facilitate removal of bolts.</p>		
13.01.02	<p>Flanges</p> <p>Insulation on flanges shall be by means of blocks of insulating material securely bound to the flange by wire loops. Such blocks of insulation shall be long enough to overlap the adjacent pipe insulation by an amount equal to the thickness of adjacent pipe insulation. Smooth finish shall be obtained by the application of insulating cement. Alternatively, sectional pipe insulation of proper diameter may be used. Insulation on flanges shall not be done until the pipe and equipment have been in service during the initial operation and till all the flange bolts have been retightened.</p>		
13.01.03	<p>Bends and Elbows</p> <p>Insulation on bends and elbows shall be cut into sections sufficiently short to form a reasonable smooth external surface. After the application of insulation material in place, it shall be smoothly coated with insulating cement. Elbows may be insulated as above or alternatively by means of specially moulded insulation enclosures.</p>		
13.01.04	<p>Cladding</p> <p>Cladding shall be of aluminium sheet of thickness as per details given in detail Technical Specification or will be provided during detail engineering shall be machine rolled and formed to accurately fit insulation curvatures. Cladding shall be secured using self-tapping screws. Screws shall be adequate number and so located as to produce tight joints. The spacing of screws shall be as far as possible uniform and on centres not exceeding 150 mm. For outside diameters less than 230 mm, spacing of screws shall be on centres not exceeding 100 mm. adequate number of screws shall be provided for fixing the cladding and be so placed in such</p>		
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	<p>locations, as to produce a smooth cladding finish without bellying'. Insulated elbows having insulated diameters less than 330 mm shall be provided with preformed smooth aluminium elbow jackets. Wherever possible, all joints should be lapped a minimum of 50 mm with joints facing downwards and so placed that they are obscured from normal points of vision. All the joints in the cladding shall be made with suitable provisions for expansions. All butt joints such as those at piping tees shall be made using rolled seams. In addition, to prevent galvanic corrosion, suitable action, as specified at clause no 13.02.00 of this chapter, shall be taken.</p>	
13.01.05	<p>Valves and Fittings</p> <p>All valves and fittings (above valve size of 2 inches) installed in the pipelines shall also be applied with insulation and furnished with suitably shaped boxes so as to facilitate easy dismantling of the fittings. The insulation thickness for valves, valve fittings etc., shall be same as that used on the line on which they are installed. All voids shall be properly filled up with insulating material and as per the directions of the Employer.</p>	
13.02.00	<p>Protection of Equipment during Insulation Applications</p> <p>All equipment and structures shall be suitably protected from damage while applying insulation after completion of insulation. All equipment and structures shall be thoroughly cleaned and remove insulating materials which might have fallen on them.</p>	
14.00.00	<p>CODE REQUIREMENTS</p> <p>The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant Indian Electricity Rules & Codes, Indian Boiler Regulations, ASME codes and accepted good practices, the Employer's Drawings and other applicable Indian recognised codes and laws and regulations of the Government of India.</p>	
15.00.00	<p>ELECTRICAL SAFETY REGULATIONS</p>	
15.01.00	<p>In no circumstances will the Contractor interfere with fuses and electrical equipment belonging to the other Contractor or Employer.</p>	
15.02.00	<p>Before the Contractor connects any electrical appliances to any plug or socket belonging to the other Contractor or Employer, he shall:</p> <ul style="list-style-type: none"> (a) Satisfy the Employer that the appliance is in good working condition. (b) Inform the Employer of the maximum current rating, voltage and phase of the appliances. (c) Obtain permission of the Employer detailing the socket to which the appliances may be connected. <p>The Employer will not grant permission to connect until he is satisfied that</p>	
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	<div>(d) The appliance is in good condition and is fitted with suitable plug.</div> <div>(e) The appliance is fitted with a suitable cable having two earth conductors,one of which shall be an earthened metal sheath surrounding the cores.</div>			
15.03.00	No electric cable in use by the other Contractor/Employer will be disturbed without permission.No weight of any description willll be imposed on any such cable and ladder or similar equipment will rest against or to be attached with it.			
15.04.00	No reapir work shall be carried out on any live equipment.The equipment must be declared safe by the Employer and a permit to work issued before any work is carried out.			
15.05.00	The Contractor shall employ the necessary number of qualified,full time electricians to maintain his temporary electrical installation..			
16.00.00	REMOVAL OF MATERIAL No material brought to the Site shall be removed from the Site by the Contractor and/or his Sub-Contractors without the prior written approval of the Employer.			
17.00.00	INSPECTION, TESTING AND INSPECTION CERTIFICATES The provisions of the clause entitled Inspection, Testing and Inspection Certificates given in Part - C of the Technical Specification, shall also be applicable to the erection portion of the Works. The Employer shall have the right to re-inspect any equipment though previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site. If by the above inspection, the Employer rejects any equipment, the Contractor shall make good for such rejections either by replacement or modification/ repairs as may be necessary to the satisfaction of the Employer. Such replacements will also include the replacements or re-execution of such of those works of other Contractors and/or agencies, which might have got damaged or affected by the replacements or re-work done to the Contractor's work.			
18.00.00	ACCESS TO SITE AND WORKS ON SITE			
18.01.00	Suitable access to site and permission to work at the Site shall be accorded to the Contractor by the Employer in reasonable time.			
18.02.00	In the execution of the Works, no person other than the Contractor or his duly appointed representative, Sub-Contractor and workmen, shall be allowed to do work on the Site, except by the special permission, in writing by the Employer or his representative.			
19.00.00	CONTRACTOR'S SITE OFFICE ESTABLISHMENT The Contractor shall establish a Office at the Site and keep posted an authorised representative for the purpose of the Contract. Any written order or instruction of the			
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	Employer or his duly authorised representative, shall be communicated to the said authorised resident representative of the Contractor and the same shall be deemed to have been communicated to the Contractor at his legal address.		
20.00.00	CO-OPERATION WITH OTHER CONTRACTORS		
20.01.00	Employer, who may be performing other works on behalf of the Employer and the workmen who may be employed by the Employer and doing work in the vicinity of the works under the Contract. The Contractor shall also arrange to perform his work as to minimise, to the maximum extent possible, interference with the work of other Contracts and their workmen. Any injury or damage that may be sustained by the employees of the other Contractors and the Employer, due to the Contractor's work shall promptly be made good at his own expense. The Employer shall determine the resolution of any difference or conflict that may arise between the Contractor and other Contractors or between the Contractor and the workmen of the Employer in regard to their work. If the work of the Contractor is delayed because of the any acts of omission of another Contractor, the Contractor shall have no claim against the Employer on that account other than an extension of time for completing his works. Employer shall have full access to visit the contractor's site at any time for inspection and surveillance checks.		
20.02.00	The Employer shall be notified promptly by the Contractor of any defects in the other Contractor's works that could affect the Contractor's Works. The Employer shall determine the corrective measures if any, re-quired to rectify this situation after inspection of the works and such decisions by the Employer shall be binding on the Contractor.		
21.00.00	DISCIPLINE OF WORKMEN		
	The Contractor shall adhere to the disciplinary procedure set by the Employer in respect of his employees and workmen at Site. The Employer shall be at liberty to object to the presence of any representative or employee of the Contractor at the Site, if in the opinion of the Employer such employee has mis-conducted himself or is incompetent, negligent or otherwise unde-sirable then the Contractor shall remove such a person objected to and provide in his place a competent replacement.		
22.00.00	CONTRACTOR'S FIELD OPERATION		
22.01.00	The Contractor shall keep the Employer informed in advance regarding his field activity plans and schedules for carrying out each part of the works. Any review of such plan or schedule or method of work by the Employer shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall also not be considered as an assumption of any risk or liability by the Employer or any of his representatives and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.		
22.02.00	The Contractor shall have the complete responsibility for the conditions of the Work-Site including the safety of all persons employed by him or his Sub-Contractor and		
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	<p>all the properties under his custody during the performance of the work. This requirement shall apply continuously till the completion of the Contract and shall not be limited to normal working hours. The construction review by the Employer is not intended to include review of Contractor's safety measures in, on or near the Work-Site, and their adequacy or otherwise.</p>		
23.00.00	PHOTOGRAPHS AND PROGRESS REPORT		
23.01.00	<p>The Contractor shall furnish three (3) prints each to the Employer of progress photographs of the work done at Site. Photographs shall be taken as and when indicated by the Employer or his representative. Photographs shall be adequate in size and number to indicate various stages of erection. Each photograph shall contain the date, the name of the Contractor and the title of the photograph.</p>		
23.02.00	<p>The above photographs shall accompany the monthly progress report detailing out the progress achieved on all erection activities as compared to the schedules. The report shall also indicate the reasons for the variance between the scheduled and actual progress and the action proposed for corrective measures, wherever necessary.</p>		
23.03.00	<p>The Contractor shall submit the progress of work in video cassettes (2 copies) quarterly highlighting the progress and constraints at site.</p>		
24.00.00	MAN-POWER REPORT		
24.01.00	<p>The Contractor shall submit to the Employer, on the first day of every month, a man hour schedule for the month, detailing the man hours scheduled for the month, skill-wise and area-wise.</p>		
24.02.00	<p>The Contractor shall also submit to the Employer on the first day of every month, a man power report of the previous month detailing the number of persons scheduled to have been employed and actually employed, skill-wise and the areas of employment of such labour.</p>		
25.00.00	<p>PROTECTION OF WORK</p> <p>The Contractor shall have total responsibility for protecting his works till it is finally taken over by the Employer. No claim will be entertained by the Employer or the representative of the Employer for any damage or loss to the Contractor's works and the Contractor shall be responsible for complete restoration of the damaged works to original conditions to comply with the specification and drawings. Should any such damage to the Contractor's Works occur because of other party not being under his supervision or control, the Contractor shall make his claim directly with the party concerned. If disagreement or conflict or dispute develops between the Contractor and the other party or parties concerned regarding the responsibility for damage to the Contractor's Works the same shall be resolved as per the provisions of the as specified at clause no 20.00.00- of this chapter entitled "Co-operation with other Contractors." The Contractor shall not cause any delay in the repair of such damaged Works because of any delay in the resolution of such disputes. The Contractor shall proceed to repair the Work immediately and no cause thereof will be assigned pending resolution of such disputes.</p>		
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<p>26.00.00</p> <p>26.01.00</p> <p>26.02.00</p> <p>26.03.00</p> <p>26.04.00</p> <p>26.05.00</p>	<p>EMPLOYMENT OF LABOUR</p> <p>In addition to all local laws and regulations pertaining to the employment of labour to be complied with by the Contractor pursuant to GCC, the Contractor will be expected to employ on the work only his regular skilled employees with experience of the particular work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.</p> <p>All travelling expenses including provisions of all necessary transport to and from Site, lodging allow-ances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor.</p> <p>The hours of work on the Site shall be decided by the Employer and the Contractor shall adhere to it. Working hours will normally be eight (8) hours per day - Monday through Saturday.</p> <p>Contractor's employees shall wear identification badges while on work at Site.</p> <p>In case the Employer becomes liable to pay any wages or dues to the labour or any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contact Labour Regulation Abolition Act or any other law due to act of omission of the Contractor, the Employer may make such payments and shall recover the same from the Contractor's Bills.</p>		
<p>27.00.00</p> <p>27.01.00</p> <p>27.02.00</p> <p>27.03.00</p> <p>27.04.00</p>	<p>FACILITIES TO BE PROVIDED BY THE EMPLOYER</p> <p>Electricity</p> <p>Refer to construction power, as envisaged at Clause 1.15.00 of Sub Section-II-B, Part A, Sec VI of Technical specification.</p> <p>Water</p> <p>Contractor shall make all arrangements himself for the supply of construction water as well as potable water for labour and other personnel at the worksite/colony. However, drawal of construction/potable water from bore-well shall be permitted if found suitable. Any statutory clearance required shall be obtained by the contractor. Assistance, if required shall be provided by the owner.</p> <p>Communication</p> <p>The Employer will extend the telephone facilities, if available at Site, for purposes of Contract. The Contractor shall be charged at actuals for such facili-ties.</p> <p>Railway Siding</p> <p>Railway siding shall be provided by owner (up to plant entry point) for coal transportation to site. However the same may not be available to the bidder for material/supplies transport etc. Bidder has to plan its own arrangement for movement of ODC consignment to plant site.</p>		
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<p>Further, irrespective of readiness of railway siding, owner reserves the option of coal supply in stackyard before the synchronization of first unit for which bidder has to ensure readiness of coal supply system up to mill bunker.</p> <p>28.00.00 FACILITIES TO BE PROVIDED BY THE CONTRACTOR</p> <p>28.01.00 Contractor's site office Establishment</p> <p>The Contractor shall establish a site office at the site and keep posted an authorized representative for the purpose of the contract, pursuant to GCC. The site office will include one conference meeting room (250-300 Sq Ft) for site meetings between the Contractor and the Employer. The contractor shall also provide four (4) furnished office rooms (150-250 SqFt) for use by the Employer to facilitate effective co-ordination during the tenancy of the contract.</p> <p>28.02.00 Tools, tackles and scaffoldings</p> <p>The Contractor shall provide all the construction equipments, tools, tackles and scaffoldings required for pre-assembly, installation, testing, commissioning and conducting Guarantee tests of the equipments covered under the Contract. He shall submit a list of all such materials to the Employer before the commencement of pre-assembly at Site. These tools and tackles shall not be removed from the Site without the written permission of the Employer. The Contractor shall arrange Dozer, Hydra, Cranes, Trailer, etc. for the purpose of fabrication, erection and commissioning.</p> <p>28.03.00 Testing Equipment and Facilities:</p> <p>The contractor shall provide the necessary testing, equipment and facilities.</p> <p>28.04.00 Site laboratory for civil works:</p> <p>Contractor shall provide and maintain a site laboratory for the testing of construction material under the direction and general supervision of employer.</p> <p>28.05.00 First-aid</p> <p>28.05.01 The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Contractor's personnel shall be trained in administering first-aid.</p> <p>28.05.02 The Employer will provide the Contractor, in case of any emergency, the services of an ambulance for transportation to the nearest hospital.</p> <p>28.06.00 Cleanliness</p> <p>28.06.01 The Contractor shall be responsible for keeping the entire area allotted to him clean and free from rubbish, debris etc. during the period of Contract. The Contractor shall employ enough number of special personnel to thoroughly clean his work-area at least once in a day. All such rubbish and scrap material shall be stacked or disposed in a place to be identified by the Employer. Materials and stores shall be so arranged</p>			
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28.06.02	<p>to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of a flame resistant, oil proof sheet shall be provided to protect the floor from such damage.</p> <p>Similarly the labour colony, the offices and the residential areas of the Contractor's employees and workmen shall be kept clean and neat to the entire satisfaction of the Employer. Proper sanitary arrangements shall be provided by the Contractor, in the work-areas, office and residential areas of the Contractor.</p>		
28.07.00	<p>The Contractor shall provide two nos. multi-utility vehicles (8 to 10 seater) for facilitating movement of Employer's official of the Project.</p>		
29.00.00	<p>LINES AND GRADES</p> <p>All the Works shall be performed to the lines, grades and elevations indicated on the drawings. The Contractor shall be responsible to locate and layout the Works. Basic horizontal and vertical control points will be established and marked by the Employer at Site at suitable points. These points shall be used as datum for the works under the Contract. The Contractor shall inform the Employer well in advance of the times and places at which he wishes to do work in the area allotted to him so that suitable datum points may be established and checked by the Employer to enable the Contractor to proceed with his works. Any work done without being properly located may be removed and/or dismantled by the Employer at Contractor's expense.</p>		
30.00.00	<p>FIRE PROTECTION</p>		
30.01.00	<p>The work procedures that are to be used during the erection shall be those which minimise fire hazards to the extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the Site at least once each day. Fuels, oils and volatile or flammable materials shall be stored away from the construction and equipment and materials storage areas in safe containers. Untreated canvas, paper, plastic or other flammable flexible materials shall not at all be used at Site for any other purpose unless otherwise specified. If any such materials are received with the equipment at the Site, the same shall be removed and replaced with acceptable material before moving into the construction or storage area.</p>		
30.02.00	<p>Similarly corrugated paper fabricated cartons etc. will not be permitted in the construction area either for storage or for handling of materials. All such materials used shall be of water proof and flame resistant type. All the other materials such as working drawings, plans etc. which are combustible but are essential for the works to be executed shall be protected against combustion resulting from welding sparks, cutting flames and other similar fire sources.</p>		
30.03.00	<p>All the Contractor's supervisory personnel and sufficient number of workers shall be trained for fire-fighting and shall be assigned specific fire protection duties. Enough of such trained personnel must be available at the Site during the entire period of the Contract.</p>		
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30.04.00	The Contractor shall provide enough fire protection equipment of the types and number for the warehouses, office, temporary structures, labour colony area etc. Access to such fire protection equipment, shall be easy and kept open at all time.		
31.00.00	SECURITY The Contractor shall have total responsibility for all equipment and materials in his custody stores, loose, semi-assembled and/or erected by him at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss. All materials of the Contractor shall enter and leave the Employer Site only with the written permission of the Employer in the prescribed manner.		
32.00.00	CONTRACTOR'S AREA LIMITS The Employer will mark-out the boundary limits of access roads, parking spaces, storage and construction areas for the Contractor and the Contractor shall not trespass the areas not so marked out for him. The Contractor shall be responsible to ensure that none of his personnel move out of the areas marked out for his operations. In case of such a need for the Contractor's personnel to work out of the areas marked out for him the same shall be done only with the written permission of the Employer.		
33.00.00	CONTRACTOR'S CO-OPERATION WITH THE EMPLOYER In case where the performance of the erection work by the Contractor affects the operation of the system facilities of the Employer, such erection work of the Contractor shall be scheduled to be performed only in the manner stipulated by the Employer and the same shall be acceptable at all times to the Contractor. The Employer may impose such restrictions on the facilities provided to the Contractor such as electricity, etc. as he may think fit in the interest of the Employer and the Contractor shall strictly adhere to such restrictions and co-operate with the Employer. It will be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and operation of the equipment systems which are erected by him. The Contractor shall also be responsible for flushing and initial filling of all the oil and lubricants required for the equipment furnished and installed by him, so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in documents and specifications.		
34.00.00	PRE-COMMISSIONING AND COMMISSIONING ACTIVITIES		
34.01.00	GENERAL		
34.01.01	The Contractor upon completion of installation of equipments and systems, shall conduct pre-commissioning and commissioning activities, to make the equipment/systems ready for safe, reliable and efficient operation on sustained basis. All pre-commissioning/commissioning activities considered essential for such readiness of the equipment/systems including those mutually agreed and included in		
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34.01.02	<p>the Contractor's quality assurance programme as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the contractor.</p> <p>The pre-commissioning and commissioning activities including Guarantee/ demonstration/acceptability tests, checks and trial operations of the equipment/ systems furnished and installed by the contractor shall be the responsibility of the Contractor as detailed in relevant clauses in Technical Specification. The Contractor shall provide, in addition, test instruments, calibrating devices etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Contractor's workmen required for the above test shall always be present at site during such operations.</p>	
34.01.03	<p>The following activities shall be carried out by the contractor, 18 month prior to schedule date of commissioning of the equipment/systems installed by him.</p> <p>(a.) The contractor shall furnish the organization chart of his operation and commissioning engineers for the acceptance of employer. Adequate number of operation and commissioning engineers shall be deployed by the contractor to effectively meet the requirement of round the clock operation in shifts also, till the plant is taken over by the employer.</p> <p>(b.) The contractor shall submit the bio-data containing the details of experience of his operation and commissioning engineers for the acceptance of employer.</p> <p>(c.) The contractor shall furnish the deployment schedule of his operation and commissioning engineers for the acceptance of the employer.</p> <p>(d.) Apart from above, contractor shall ensure deployment of sufficient skilled/semi-skilled/unskilled manpower during pre-commissioning and commissioning activities.</p>	
34.01.04	<p>It shall be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and initial operation of the equipment/systems which are installed by him.</p>	
34.01.05	<p>The Contractor shall also be responsible for flushing and initial filling of all oils and lubricants required for the equipment furnished and installed by him so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in these specifications and documents.</p>	
34.02.00	<p>COMMISSIONING DOCUMENTATION</p>	
34.02.01	<p>The contractor shall submit the commissioning documentation, comprising of Standard checklists, pre-commissioning procedures, testing schedules, commissioning schedules and commissioning networks for various equipment/ systems covered under the contract, for the approval of employer.</p>	
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34.02.02	Standard checklist, as the name suggests, shall be a fairly general documents, containing the list of all checks required to be carried out for similar and repetitive type of equipment to ensure consistent and thorough checking. An indicative list of such equipment is enclosed as Annexure I.	
34.02.03	The testing schedule is a document, designed for safe and systematic commissioning of individual equipment/sub-system (for example Boiler Feed Pump, condensate pump, compressor etc) Commissioning schedule is a document envisaged for commissioning of a system (for example feed system, Condensate system, Compressed Air system, Fire water system, Unit commissioning etc). The testing/Commissioning schedule shall have a standard format in order to maintain consistency of presentation, content and reporting. A brief write up on the contents of the Testing Schedule/Commissioning Schedule is enclosed as Annexure-II.	
34.02.04	The contractor shall submit the list of commissioning documentation to be submitted by him, alongwith their submission schedule for various equipment/systems covered under the contract, with in 6(six) month from the date of award of contract, for the acceptance of employer.	
34.02.05	The Contractor shall submit the commissioning documentation, for various equipment/covered under the contract, for the approval of employer, at least 18 months before the scheduled date of commissioning of the equipment/systems.	
34.03.00	COMMISSIONING ACTIVITIES	
34.03.01	Upon completion of pre-commissioning activities/tests, the contractor shall initiate commissioning of facilities. During commissioning the Contractor shall carry out system checking and reliability trials on various parts of the facilities.	
34.03.02	Contractor shall carry out the checks/tests at site to prove to the Employer that each equipment of the supply complies with requirements stipulated and is installed in accordance with requirements specified.	
34.03.03	Before the plant is put into initial operation the Contractor shall be required to conduct test to demonstrate to the Employer that each item of the plant is capable of correctly performing the functions for which it was specified and its performance, parameters etc. are as per the specified/approved values. These tests may be conducted concurrently with those required under commissioning sequence.	
34.03.04	The Contractor shall also demonstrate the performance of all C&I equipment, the tests on main equipment of prior to that as the case may be.	
34.03.05	Other tests shall be conducted, if required by the Employer, to establish that the plant equipment are in accordance with requirements of the specifications.	
34.03.06	The Contractor shall conduct all the commissioning tests and undertake commissioning activities pertaining to all other auxiliaries and equipments including all electrical and C&I equipment/systems not specifically brought out above but are within the scope of work and facilities being supplied and installed by the Contractor	
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	and follow the guidelines indicated above or elsewhere in these technical specifications.	
34.05.00	Initial Operation Upon completion of system checking/Tests as above and as a part of commissioning of facilities, complete plant/facilities shall be put on initial operation as stipulated in General Technical Requirements.	
35.00.00	MATERIALS HANDLING AND STORAGE	
35.01.00	All the equipments furnished under the Contract and arriving at Site shall be promptly received, unloaded and transported and stored in the storage spaces by the Contractor.	
35.02.00	Contractor shall be responsible for examining all the shipment and notify the Employer immediately of any damage, shortage, discrepancy etc. for the purpose of Employer's information only. The Contractor shall submit to the Employer every week a report detailing all the receipts during the week. However, the Contractor shall be solely responsible for any shortages or damage in transit, handling and / or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.	
35.03.00	The Contractor shall maintain an accurate and exhaustive record detailing out the list of all equipment received by him for the purpose of erection and keep such record open for the inspection of the Employer.	
35.04.00	All equipment shall be handled very carefully to prevent any damage or loss. No bare wire ropes, slings, etc. shall be used for unloading and/or handling of the equipment without the specific written permission of the Employer. The equipment stored shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the store shall be moved to the actual location at the appropriate time so as to avoid damage of such equipment at Site.	
35.05.00	All electrical panels, controls gear, motors and such other devices shall be properly dried by heating before they are installed and energised. Motor bearings, slip rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and periodically inspected. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion due to prolonged storage.	
35.06.00	All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months from the date of receipt till the date of commissioning and a record of such measured insulation values maintained by the Contractor. Such records shall be open for inspection by the Employer.	
35.07.00	The Contractor shall ensure that all the packing materials and protection devices used for the various equipments during transit and storage are removed before the equipment are installed.	
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35.08.00	The consumables and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage.	
35.09.00	All the materials stored in the open or dusty location must be covered with suitable weatherproof and flame-proof covering material wherever applicable.	
35.10.00	If the materials belonging to the Contractor are stored in areas other than those earmarked for him, the Employer will have the right to get it moved to the area earmarked for the Contractor at the Contractor's cost.	
35.11.00	The Contractor shall be responsible for making suitable indoor storage facilities to store all equipment which require indoor storage. Normally, all the electrical equipments such as motors, control gear, generators, exciters and consumables like electrodes, lubricants etc. shall be stored in the closed storage space. The Employer, in addition, may direct the Contractor to move certain other materials, which in his opinion will require indoor storage, to indoor storage areas which the Contractor shall strictly comply with.	
36.00.00	CONSTRUCTION MANAGEMENT	
36.01.00	The field activities of the Contractors working at Site, will be coordinated by the Employer and the Employer decision shall be final in resolving any disputes or conflicts between the Contractor and other Contractors and tradesmen of the Employer regarding scheduling and co-ordination of work. Such decision by the Employer shall not be a cause for extra compensation or extension of time for the Contractor.	
36.02.00	The Employer shall hold weekly meetings of all the Contractors working at Site, at a time and place to be designated by the Employer. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Employer and shall strictly adhere to those decisions in performing his Works. In addition to the above weekly meeting, the Employer may call for other meeting either with individual Contractors or with selected number of Contractors and in such a case the Contractor if called, will also attend such meetings.	
36.03.00	Time is the essence of the Contract and the Contractor shall be responsible for performance of his works in accordance with the specified construction schedule. If at any time, the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such actions in writing to the Employer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.	
36.04.00	The Employer shall however not be responsible for provision of additional labour and/or materials or supply or any other services to the Contractor except for the co-ordination work between various Contractors as set out earlier.	
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36.05.00	<p>Site management during construction phase till handing over of plant</p> <p>Bidder shall ensure that the plant site within the plant boundary is managed in a coordinated and professional way all through the construction phase till handing over of plant, ensuring safe, easy & unhindered working conditions and a healthy & hygienic working environment at site. He shall ensure the following measures at site while executing the project.</p> <p>a) Unhindered motorable road access to all work areas and facilities both during the construction/erection and as they get completed progressively. Required temporary access roads other than the permanent roads shall also be provided. Bidder shall prioritize the construction of approach roads, roads around the main plant block, roads to office & storage areas and the offsite areas from the start of project itself. He shall finalize and submit the complete road layout plan along with priority and completion schedule immediately after the award for review by the Employer .He shall ensure that the roads are promptly repaired and maintained against any damages due to movement of traffic/heavy trailers & cranes etc providing motorable access at all times. Adequate onsite stock of road materials shall be kept and maintained disturbed over the site for repairs especially before the monsoon period.</p> <p>b) Proper drainage of rain water, ground water from excavations, water flows from batching plant / construction sites etc. He shall prioritize the construction of permanent drains from the start of the project itself. Till such time the permanent drainage network is done, he shall construct adequate temporary drains to ensure that there is no accumulation /stagnation of water in the plant site. Bidder may consider providing pre-cast RCC drains for temporary/ permanent drain construction for faster construction of drains. The drain construction shall be matched with progress of road construction for preventing damage to roads. Bidder shall provide and maintain adequate number of drainage pumps (both electrical and diesel operated) of suitable capacity for pumping out accumulated water especially during the monsoon periods. All drain diversions required shall be undertaken at the start of the project itself.</p> <p>c) The plant site is fully secured against unauthorized access.</p> <p>d) Proper housekeeping by systematic and proper disposal of earth from excavations(separately for usable & surplus earth), muck (from pile bores or otherwise), wastes (from dismantling of pile tops, concrete works etc), packing & insulation wastes, steel scrap, cable wastes etc generated during construction / erection works. Suitable disposal sites for each of above shall be identified in the layout and at site in the beginning of the project itself. It shall be ensured that all agencies engaged by the bidder follow the discipline to dispose off of earth spoils and wastes at the designated places. Preferably once in a week suitable time slot will be identified for housekeeping by all agencies and suitable instructions shall be issued in this regard. Bidder may engage a separate agency or identify a gang for collection of wastes and disposal to designated places. Suitable arrangement / tie-up will also be made for periodic disposal of wastes/ scrap from the designated places.</p>		
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	<p>e) All fabrication areas shall be suitably hard crusted to provide a water free and proper working platforms. Suitable sheds preferably pre engineered structures to be provided for paint shops, fabrication workshops etc for ensuring all weather work conditions for onsite structural works. For the main plant and auxiliary buildings, bidder should preferably plan the works in such a way that structural fabrication is done in suppliers' offsite works / workshops and onsite fabrication works are avoided / kept minimum.</p> <p>f) Suitable onsite maintenance workshop for day to day breakdown maintenance heavy plant and equipment like batching plants, cranes, earth moving equipment, welding equipment etc. The workshop shall have stock of frequently needed spares and suitable repair facilities with experienced technicians/mechanics. A central test laboratory equipped with test equipment for routine tests like tests on soil, concrete, bricks, aggregates, welds etc with experienced staff shall be established at the start of the project itself.</p> <p>g) All office and covered store buildings of the bidder and its agencies shall be of prefab/ pre-engineered / porta cabin construction. Shabby semi finished constructions in brickwork/ GI / asbestos roof etc shall not be permitted.</p> <p>h) First aid facilities and amenities like rest rooms, suitable pre engineered toilets (separate for men and women), drinking water fountains/tanks, canteen, crèche for women workers shall be planned and established at the beginning of the project itself. These facilities shall be distributed over the plant area to enable easy access by the construction workers and staff and shall be marked on the plant layout. Suitable treatment for toilet discharge, like bio digesters etc shall be planned and conventional septic tanks / soak pits etc shall be avoided.</p> <p>i) Proper lighting of all construction / erection areas. Bidder shall erect adequate number of high lighting masts in main plant, offsite, office and store areas for lighting during night. DG sets of adequate capacity shall be provided for emergency backup. The street lighting along the roads shall also be prioritized along with road construction. The construction power ring main shall be planned and erected immediately after the award.</p> <p>j) Well planned and coordinated storage and movement of plant, equipment and construction materials. System wise / agency wise storage / laydown areas shall be planned and marked on the plant layout at the beginning itself. Bidder shall ensure that all its agencies comply to the areas allocated to them and follow the designated storage and movement plans. Adequate covered storage shall be constructed for storage of critical equipments like switchgears, MCCs, insulation etc.</p> <p>k) Proper access control for construction workers, staff and visitors. Bidder shall ensure that suitable electronic based gate pass system is in place from start of project itself to keep record and track of all workers, staff and visitors entering/exiting the plant premises shift wise on daily basis.</p>		
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	<p>l) Compliance to all safety requirements as specified in this document. Bidders shall establish a safety centre at the start of the project itself. It shall have a 24X7 manned safety control room in addition to a permanent safety equipment display room, separate training / lecture hall with AV facilities for safety training, store room with adequate stock of specified safety equipment, a first aid room and other amenities. Bidder shall install 25 Nos. CCTV cameras at all strategic locations in the plant area which shall be linked to the safety control room.</p> <p>m) Compliance to all environment and other conditions stipulated by the concerned statutory authorities while according clearance / NOC (No objection certificate) to the project. Bidder shall ensure adequate sprinkling of water by deploying water tankers to prevent the fugitive dust nuisance during construction.</p> <p>n) Development of suitable landscape & green belt areas and rainwater harvesting within the plant premises. Bidder shall plan to develop the landscape & green belt areas and rainwater harvesting from the start of the project itself. The landscape and rainwater harvesting plan shall be finalized immediately after award of work and suitable work plan with priority and schedule shall also be finalized thereafter. Top soil before excavation shall be suitably preserved and stacked for landscape and green belt development.</p> <p>o) Provision of adequate shelters, water supply, sanitation and lighting in construction workers and staff camps. No camps for workers and staff shall be permitted within the plant premises and Bidder shall make separate arrangement outside the plant premises for locating and development of camps for construction workers and staff. The designated areas shall be suitably developed with infrastructure like roads, drains, water supply and sewerage and shall be free from water logging. Suitable low cost shelters will be provided for the workers. Complete area shall be secured by fencing and shall be provided adequate area lighting. Suitable waste disposal, shopping and recreation facilities will be developed in these camps.</p> <p>Bidder shall ensure that due importance is given to site management as discussed above and a detailed work plan considering the above aspects is finalized immediately after the award. A senior level executive shall be identified who shall be responsible for implementation of the work plan. Suitable format for progress reporting on site management plan shall be developed and made part of the project progress report. The progress on implementation of above work plan shall be reviewed along with project progress in the monthly project review meetings with Employer. In case the progress on site management plan is unsatisfactory, Employer may withhold up to 1% of the monthly running bill (for civil and site erection works) till such time the required progress is demonstrated. Incase in the opinion of Employer, bidder's actions on site management aspects is not adequate, Employer may get the relevant work executed through a separate agency and deduct the expenses incurred from Bidder's bill along with overheads @10 %.</p>		
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37.00.00	FIELD OFFICE RECORDS The Contractor shall maintain at his Site Office up-to- date copies of all drawings, specifications and other Contract Documents and any other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain in addition the continuous record of all changes to the above Contract Documents, drawings, specifications, supplementary data, etc. effected at the field and on completion of his total assignment under the Contract shall incorporate all such changes on the drawings and other Engineering data to indicate as installed conditions of the equipment furnished and erected under the Contract. Such drawings and Engineering data shall be submitted to the Employer in required number of copies.		
38.00.00	CONTRACTOR'S MATERIALS BROUGHT ON TO SITE		
38.01.00	The Contractor shall bring to Site all equipment, components, parts, materials, including construction equipment, tools and tackles for the purpose of the Works under intimation to the Employer. All such goods shall, from the time of their being brought vest in the Employer, but may be used for the purpose of the Works only and shall not on any account be removed or taken away by the Contractor without the written permission of the Employer. The Contractor shall nevertheless be solely liable and responsible for any loss or destruction thereof and damage thereto.		
38.02.00	The Employer shall have a lien on such goods for any sum or sums which may at any time be due or owing to him by the Contractor, under, in respect of or by reasons of the Contract. After giving a fifteen (15) days notice in writing of his intention to do so, the Employer shall be at liberty to sell and dispose off any such goods, in such manner as he shall think fit including public auction or private treaty and to apply the proceeds in or towards the satisfaction of such sum or sums due as aforesaid.		
38.03.00	After the completion of the Works, the Contractor shall remove from the Site under the direction of the Employer the materials such as construction equipment, erection tools and tackles, scaffolding etc. with the written permission of the Employer. If the Contractor fails to remove such materials, within fifteen (15) days of issue of a notice by the Employer to do so then the Employer shall have the liberty to dispose off such materials as detailed under as specified at clause no 38.02.00- of this chapter and credit the proceeds thereto to the account of the Contractor.		
39.00.00	PROTECTION OF PROPERTY AND CONTRACTOR'S LIABILITY		
39.01.00	The Contractor shall be responsible for any damage resulting from his operations. He shall also be re-sponsible for protection of all persons including members of public and employees of the Employer and the employees of other Contractors and Sub- Contractors and all public and private property including structures, building, other plants and equipments and utilities either above or below the ground.		
39.02.00	The Contractor will ensure provision of necessary safety equipment such as barriers, sign - boards, warning lights and alarms, etc. to provide adequate protection to persons and property. The Contractor shall be responsible to give reasonable notice		
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	to the Employer and the Employers of public or private property and utili-ties when such property and utilities are likely to get damaged or injured during the performance of his Works and shall make all necessary arrangements with such Employers, related to removal and/or replacement or protection of such property and utilities.												
40.00.00	PAINTING For painting refer Part-A, sub section-III, Section VI of Technical specification. Painting for structures shall conform to the painting specification specified in Part-B under Civil. Painting for piping shall conform to the painting specification given in Part-B of the respective chapter. Painting for Electrical equipments/systems shall conform to the painting specification given in Electrical portion of Part-A and Part-B of technical specifications.												
41.00.00	INSURANCE												
41.01.00	In addition to the conditions covered under the Clause entitled "Insurance" in Section General Conditions of Contract (GCC), the following provisions will also apply to the portion of works to be done beyond the Contractor's own or his Sub-Contractor's manufacturing Works.												
41.02.00	Workmen's Compensation Insurance This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against claims for injury, disa-bility disease or death of his or his Sub-Contractor's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabili-ties shall not be less than the following: <table><tr><td>Workmen's Compensation</td><td>-</td><td>As per Statutory Provisions</td></tr><tr><td>Employee's Liability</td><td>-</td><td>As per Statutory Provisions</td></tr></table>				Workmen's Compensation	-	As per Statutory Provisions	Employee's Liability	-	As per Statutory Provisions			
Workmen's Compensation	-	As per Statutory Provisions											
Employee's Liability	-	As per Statutory Provisions											
41.03.00	Comprehensive Automobile Insurance This insurance shall be in such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the Employer's men and damage to the property of other arising from the use of motor vehicles during on or off the Site operations, irrespective of the Ownership of such vehicles. The liability covered shall be as herein indicated : <table><tr><td>Fatal Injury</td><td>:</td><td>Rs.100,000 each person</td></tr><tr><td></td><td>:</td><td>Rs.200,000 each occurrence</td></tr><tr><td>Property Damage</td><td>:</td><td>Rs.100,000 each occurrence</td></tr></table>				Fatal Injury	:	Rs.100,000 each person		:	Rs.200,000 each occurrence	Property Damage	:	Rs.100,000 each occurrence
Fatal Injury	:	Rs.100,000 each person											
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41.04.00	Comprehensive General Liability Insurance		
41.04.01	The insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members of public or damage to property of others, due to any act or omission on the part of the Contractor, his agents, his employees, his representatives and Sub-Contractors or from riots, strikes and civil commotion. This insurance shall also cover all the liabilities of the Contractor arising out of the Clause entitled "Defence of Suits" in Section General Conditions of Contract (GCC).		
41.04.02	The hazards to be covered will pertain to all the Works and areas where the Contractor, his Sub-Contractors, his agents and his employees have to perform work pursuant to the Contract.		
41.05.00	The above are only illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all his liabilities either direct or indirect, in pursuance of the Contract.		
42.00.00	UNFAVOURABLE WORKING CONDITIONS The Contractor shall confine all his field operations to those works which can be performed without subjecting the equipment and materials to adverse effects during inclement weather conditions, like monsoon, storms, etc. and during other unfavourable construction conditions. No field activities shall be performed by the Contractor under conditions which might adversely affect the quality and efficiency thereof, unless special precautions or measures are taken by the Contractor in a proper and satisfactory manner in the performance of such Works and with the concurrence of the Employer. Such unfavourable construction conditions will in no way relieve the Contractor of his responsibility to perform the Works as per the schedule.		
43.00.00	PROTECTION OF MONUMENTS AND REFERENCE POINTS The Contractor shall ensure that any finds such as relic, antiquity, coins, fossils, etc. which he may come across during the course of performance of his Works either during excavation or elsewhere, are properly protected and handed over to the Employer. Similarly the Contractor shall ensure that the bench marks, reference points, etc., which are marked either with the help of Employer or by the Employer shall not be disturbed in any way during the performance of his Works. If, any work is to be performed which disturb such reference, the same shall be done only after these are transferred to other suitable locations under the direction of the Employer. The Contractor shall provide all necessary materials and assistance for such relocation of reference points etc.		
44.00.00	WORK & SAFETY REGULATIONS		
44.01.00	General i) The contractor shall comply with all the requirements of "The Building and Other Construction Workers (Regulation of Employment & Conditions of		
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	<p>Service) Act," 1996 and its Central Rule 1998 / State Rules and any other statutory requirements as applicable.</p> <p>ii) The Contractor shall follow NTPC Safety Rules as issued from time to time with respect to safety in construction & erection.</p> <p>iii) The contractor shall have the approved Safety, Health and Environment (SHE) Policy in respect of Safety and health of Building Workers and it shall be circulated widely and displayed at conspicuous place in Hindi and local language understood by the majority of the workers. A copy of the safety policy should be submitted to Engineer in charge.</p> <p>iv) The contractor shall submit the safety plan comprising of methods to implement the Safety Policy/ Rules, Risk assessment and ensuring Safety at work areas, Safety audits, inspections and its compliance, Supervision and responsibility to ensure Safety at various levels, Safety training to employees, review of Safety and accident analysis, ensure Health and Safety Procedures to prevent accidents to Engineer I/c for approval as per the format of Safety plan as annexed at Annexure - III.</p> <p>v) The Contractors shall ensure proper safety of all the workmen, materials, plant and equipment belonging to him or to the Employer or to others, working at the Site.</p> <p>vi) All equipments used in construction and erection by the contractor shall meet BIS / International Standards and where such standards do not exist, the Contractor shall ensure these to be absolutely safe. All equipments shall be strictly operated and maintained by the contractor in accordance with manufacturer's operation manual. The contractor should also follow Guidelines / Rules of the Employer in this regard.</p> <p>vii) The Contractors shall provide suitable latest Personal Protective Equipments of prescribed standard to all their employees and workmen according to the need. The Engineer I/c shall have the right to examine these safety equipments to determine their suitability, reliability, acceptability and adaptability. The contractor should also ensure these before their use at worksite.</p> <p>viii) The Contractor shall provide safe working conditions to all workmen and employees at his workplace including safe means of access, railings, stairs, and ladders, scaffolding, work platforms, toe boards etc. The scaffoldings shall be erected under the control and supervision of an experienced and competent person. For erection of scaffolds, access, work platforms etc. shall be good and the contractor shall use standard quality of material.</p> <p>ix) The Contractor shall follow and comply with all the Safety Rules, standards, code of practices of NTPC and relevant provisions of applicable laws pertaining to the safety of workmen, employees, plant and equipment as may be prescribed from time to time without any protest or contest or reservation. In case of any unconformity between statutory requirement and the Safety Rules of the Employer referred above, the latter shall be binding on the</p>		
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	<p>Contractor unless the statutory provisions are more stringent. As and when required he can refer / obtain copy of NTPC safety documents as stated above.</p> <p>x) The contractor shall have his own arrangements with nearby hospitals for shifting and treatment of sick and injured.</p> <p>The medical examination of the workers employed in hazardous areas shall be conducted as per Rule 223 Of The Building and Other Construction Worker (Regulation of Employment and Condition of Service) Central Rule 1998 Their health records shall be maintained accordingly and to be submitted to Engineer I/c when asked for. If any worker found suffering from occupational health hazard, the worker should be shifted to suitable place of working and properly treated under intimation to Engineer I/c. The medical fitness certificate to be submitted to Engineer (I/c).</p> <p>xi) First Aid boxes equipped with requisite articles as specified in the Rule 231 of The Building and Other Construction Worker (Regulation of Employment and Condition of Service) Central Rule 1998 shall be provided at construction sites for the use of workers. Training has to be provided on first aid to workmen & office bearers working at site.</p>			
44.01.01	Emergency Action Plan <p>The contractor shall prepare an emergency action plan approved by his competent authority to handle any emergency occurred during construction work. Regular mock drills shall be organized to practice this emergency plan. The Emergency Action Plan should be widely circulated to all the employees and suitable infrastructure shall be provided to handle the emergencies.</p>			
44.01.02	Scaffolding <p>The contractor shall take all precautions to prevent any accidental collapse of scaffolding or fall of persons from scaffolding. The contractor should ensure that scaffolding are designed by a competent person and it erection and repairs should be done under the expert supervision. The scaffolding shall meet the required strength and other requirements for the purpose for which the scaffold is erected. The material used for scaffold should conform to the BIS / International standards.</p>			
44.01.03	Opening <p>The contractor shall ensure that there is no opening in any working platform/any floor of the building, which may cause fall of workers or material. When ever an opening on a platform/any floor of the building is unavoidable, the opening should be suitably fenced and necessary measures for protection against falling objects or building workers from such platform are taken by providing suitable safety nets, safety belts or other similar means.</p>			
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44.01.04	<p>Explosives</p> <p>The contractor shall take all precautions while handling, using, storing or transporting of all explosives. Before usage of any explosive necessary warning / danger signals be erected at conspicuous places to warn the workers and general public. The contractor should strictly ensure that all measures and precautions required to be complied for use, handling, storing or transportation of explosives under the rules framed under the Explosives Act, 1884.</p>		
44.02.00	<p>Fencing of Machinery</p> <p>The contractor shall provide suitable fencing or guard to all dangerous and moving parts of machinery.</p> <p>The contractor shall not allow any of the employees to clean, lubricate, repair, adjust or examine during machinery in motion, which may cause injury to the person.</p>		
44.03.00	<p>Carrying of Excessive Weight by a Worker</p> <p>The worker shall not be allowed to lift by hand or carry over his head, back or shoulder more than the maximum limit set by the prescribed rules for the construction Workers.</p>		
44.04.00	<p>Dangerous and Harmful Gases / Equipment</p> <p>The contractor shall ensure that the workers are not exposed to any harmful gases during any construction activity including excavation, tunneling, confined spaces etc.</p> <p>The contractor should not allow any worker to go into the confined space unless it is certified by Engineer (I/c) to be safe and fit for the entry to such work place. Proper record and work permits should be followed to carry out such works.</p>		
44.05.00	<p>Overhead Protection</p> <p>The contractor shall ensure that any area exposed to risk of falling materials, articles or objects is roped off or cordoned off or otherwise suitably guarded from inadvertent entry of any person.</p> <p>Wherever there is a possibility of falling of any material, equipment or construction workers while working at heights, a suitable and adequate safety net should be provided. The safety net should be in accordance with BIS Standards.</p>		
44.06.00	<p>Working at Heights</p> <p>All working platforms, ways and other places of construction work shall be free from accumulations of debris or any other material causing obstructions and tripping.</p> <p>Wherever workers are exposed to the hazard of falling into water, the contractor shall provide adequate equipment for saving the employees from drowning and rescuing from such hazards. The contractor shall provide boat or launch equipped</p>		
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44.07.00	<p>with sufficient number of life buoys, life jackets etc. manned with trained personnel at the site of such work.</p> <p>Every opening at elevation from ground level through which a building worker, vehicle, material equipment etc. may fall at a construction work shall be covered and/or guarded suitably by the contractor to prevent such falls.</p> <p>Wherever the workers are exposed to the hazards of falling from height, the contractor shall provide full harness safety belts fitted with fall arresting systems to all the employees working at higher elevations and life line of 8 mm diameter wire rope with turn buckles for anchoring the safety belts while working or moving at higher elevations. Safety nets shall also be provided for saving them from fall from heights and such equipment should be in accordance with BIS standards.</p> <p>Wherever there is a possibility of falling of any material, equipment or construction workers while working at heights, a suitable and adequate safety net should be provided. The safety net should be in accordance with BIS Standards.</p> <p>The contractor shall provide standard prefabricated ladders on the columns where the workers are required to use them as an access for higher elevations till permanent staircase is provided. The workers shall be provided with safety belts fitted with suitable fall arresting system (Fall arrestors) for climbing/getting down through ladders to prevent fall from height.</p>		
	<p>Handling of Hazardous Chemicals</p> <p>The Contractor will notify well in advance to the Engineer I/c of his intention to bring to the Site any container filled with liquid or gaseous fuel or explosive or petroleum substance or such chemicals which may involve hazards. NTPC shall have the right to prescribe the conditions, under which such container is to be stored, handled and used during the performance of the works and the Contract shall strictly adhere to and comply with such instructions. The Engineer I/c shall have the right at his sole discretion to inspect any such container or such construction plant / equipment for which material in the container is required to be used and if in his opinion, its use is not safe, he may forbid its use. No claim due to such prohibition shall be entertained by NTPC and NTPC shall not entertain any claim of the Contractor towards additional safety provisions / conditions to be provided for / constructed.</p> <p>Further, any such decision of the Engineer I/c shall not, in any way, absolve the Contractor of his responsibilities and in case, use of such a container or entry thereof into the Site area is forbidden by NTPC, the Contractor shall use alternative methods with the approval of the NTPC without any cost implication to the NTPC or extension of work schedule.</p> <p>Where it is necessary to provide and / or store petroleum products or petroleum mixtures and explosives, the Contractor shall be responsible for carrying-out such provision and / or storage in accordance with the rules and regulations laid down in Petroleum Act 1934, Explosives Act 1948, and Petroleum and Carbide of Calcium Manual published by the Chief Inspector of Explosives of India. All such storage shall have prior approval of the Engineer I/c. In case any approvals are necessary</p>		
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44.08.00	<p>from the Chief Inspector (Explosives) or any statutory authorities, the Contractor shall be responsible for obtaining the same.</p> <p>The Contractor shall be fully responsible for the safe storage of his and his Sub-contractor's radio-active sources in accordance with BARC/DAE (Bhabha Atomic Research Centre/ Department of Atomic Energy, Govt. of India) Rules and other applicable provisions. All precautionary measures stipulated by BARC/DAE in connection with use, the contractor would take storage and handling of such material.</p> <p>The contractor shall provide suitable personal protective equipments to the workers who are handling the hazardous and corrosive substances including alkalis and acids.</p> <p>As a precautionary measure the contractor should keep the bottles filled with distilled water in cupboard / Boxes near work place for emergency eye wash by worker exposed to such hazardous chemicals.</p> <p>Eye Protection</p> <p>The contractor shall provide suitable personal protective equipment to his workmen depending upon the nature of hazards and ensure their usage by the workers engaged in operations like welding, cutting, chipping, grinding or similar operations which may cause injuries to his eyes.</p>		
	<p>Excavation</p> <p>The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding material or article from any bank or side of such excavation which is more than one and a half meter above his 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>		
	<p>Electrical Hazards</p> <p>The contractor should ensure that all electrical installations at the construction work comply with the requirements of latest electricity acts / rules.</p> <p>The contractor shall take all adequate measures to prevent any worker from coming into physical contact with any electrical equipment or apparatus, machines or live electrical circuits which may cause electrical hazards during the construction work. The contractor shall provide the sufficient ELCBs / RCCBs for all the portable equipments, electrical switchboards, distribution panels etc. to prevent electrical shocks.</p> <p>The contractor should ensure use of single / double insulated hand tools or low voltage i.e., 110 volts hand tools.</p>		
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<p>44.11.00</p> <p>44.12.00</p> <p>44.13.00</p> <p>44.14.00</p> <p>44.14.01</p>	<p>The contractor should also ensure that all temporary electrical installations at the construction works are provided with earth leakage circuit breakers.</p> <p>Vehicular Traffic</p> <p>The contractor should employ vehicle drivers who hold a valid driving license under the Motor Vehicles Act, 1988.</p> <p>Lifting Appliances, Tools & Tackles, Lifting Gear And Pressure Plant & Equipment etc.</p> <p>The contractor shall ensure all the lifting appliances, tools & tackles including cranes etc., lifting gear including fixed or movable and any plant or gear, hoists, Pressure Plant and equipment etc. are in good condition and shall be examined by competent person and only certified shall be used at sites. Periodical Examination and the tests for all lifting / hoisting equipment & tackles shall be carried out. A register of such examinations and tests shall be properly maintained by the Contractor and will be promptly produced as and when desired by the Engineer I/c or by the person authorized by him.</p> <p>Excessive Noise, Vibration</p> <p>The contractor shall take adequate measures to protect the workers against the harmful effect of excessive noise or vibration. The noise should not exceed the limits prescribed under the concerned rules, Noise Pollution (Regulation and Control) Rules, 2000.</p> <p>Electrical Installations</p> <p>The Contractor shall not interfere or disturb electric fuses, wiring and other electrical equipment belonging to the Employer or other contractors under any circumstances, whatsoever, unless expressly permitted in writing by the Engineer I/c to handle such fuses, wiring or electrical equipment.</p> <p>Before the Contractor connects any electrical appliances to any plug or socket belonging to the other contractor or the NTPC, he shall</p> <ol style="list-style-type: none"> Satisfy the Engineer I/C that the appliance is in good working condition; Inform the Engineer I/C of the maximum current rating, voltage and phases of the appliances; Obtain permission of the Engineer I/C detailing the sockets to which the appliances may be connected. <p>The Engineer I/C will not grant permission to connect until he is satisfied that:</p> <p>The appliance is in good condition and is fitted with suitable plug; having earth connection with the body.</p>		
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	<p>Wherever armored / metallic sheathed multi core cable is used, the same armored / sheathed should be connected to earth.</p> <p>iv) No repair work shall be carried out on any live equipment. The Engineer I/c must declare the equipment safe and a permit to work shall be issued by the NTPC / contractor as the case may be to carry out any repair / maintenance work. While working on electric lines / equipments whether live or dead, suitable type and sufficient quantity of tools will have to be provided by the contractor to electricians / workmen / Officers.</p> <p>v) The contractor shall employ necessary number of qualified, full time Electricians / Electrical Supervisors to maintain his temporary electrical installation.</p> <p>The installations are provided with suitable ELCBs and RCCBs wherever required.</p>		
44.15.00	Safety Organisation		
44.15.01	<p>The contractor employing more than 250 workmen whether temporary, casual, probationary, regular or permanent shall employ at least one full time safety officer exclusively to supervise safety aspects of the equipments and workmen, who will coordinate with the NTPC Safety Officer. Further requirement of safety officers, if any, shall be guided by Rule 209 of The Building and Other Construction Worker (Regulation of Employment and Conditions of Service) Central Rule 1998. In case the work is being carried out through subcontractor, the employees / workmen of the sub contractor shall also be considered as the contractor's employees/workmen for the above purpose.</p> <p>In case of contractor deploying less than 250 workmen he should designate one of his Engr / supervisor or the contractor himself (if he is directly supervising the work) as safety officer in addition to his existing responsibilities. The Engr./ supervisor should get atleast 2days safety training from any reputed organization or from NTPC before resuming the work. If already trained in past the declaration along with trg. certificate to be furnished to NTPC safety officer.</p>		
44.15.02	<p>The name and address of such Safety Officer of the Contractor will be promptly informed in writing to the EIC with a copy to the Project Safety Officer before he starts work or immediately after any change of the incumbent is made during currency of the Contract.</p>		
44.16.00	<p>Reporting of Accident and Investigation</p> <p>In case any accident occurs during the construction / erection or other associated activities undertaken by the Contractor thereby causing any near miss, minor or major or fatal injury to his employees due to any reason, whatsoever, it shall be the responsibility of the Contractor to promptly inform the same to the Engineer I/C, NTPC Safety Officer with a copy to NTPC Head of Project in the prescribed form and also to all the authorities envisaged under the applicable laws.</p>		
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<p>44.17.00</p> <p>44.17.01</p> <p>44.17.02</p> <p>44.18.00</p> <p>44.19.00</p>	<p>Right to stop Work</p> <p>The Engineer I/C shall have the right at his sole discretion to stop the work, if in his opinion the work is being carried out in such a way that it may cause accidents and endanger the safety of the persons and / or property, and / or equipments. In such cases, the contractor shall be informed in writing about the nature of hazards and possible injury / accident and he shall comply to remove shortcomings promptly. The Contractor after stopping the specific work can, if felt necessary appeal against the order of stoppage of work to the Project Manager within 3 days of such stoppage of work and decision of the Project Manager in this respect shall be conclusive and binding on the Contractor.</p> <p>Fire Protection</p> <p>The Contractor shall not be entitled for any damages / compensation for stoppage of work, {Sub-Clause XVIII (I)} due to safety reasons and the period of such stoppage of work shall not be taken as an extension of time for Completion of the Facilities and will not be the ground for waiver of levy of liquidated damages.</p> <p>Penalties</p> <p>I If the Contractor fails in providing safe working environment as per the Safety Rules of NTPC or continues the work even after being instructed to stop the work by the Engineer I/C as provided in Clause XVIII (1) above, the Contractor shall be penalized at the rate of Rs. 25,000/- per day or part thereof till the instructions are complied with and so certified by the Engineer I/C. However, in case of accident, the provisions contained in Sub-Clause XX (II) below shall also apply in addition to the penalties mentioned in this sub-clause.</p> <p>II If the Contractor does not take all safety precautions and / or fails to comply with the Safety Rules as prescribed by the Employer or under the applicable law for the safety of the plant and equipment and for the safety of personnel and the contractor does not prevent hazardous conditions which cause injury to this own employees or employees of other contractors, or NTPC's employees or any other person who are at the Site or adjacent thereto, the Contractor shall be responsible for payment of penalty to NTPC as per the following schedule:-</p> <p>a) Fatal injury or accident causing death:</p> <p>Penalty @10% of contract value or Rs. 5,00,000/- per person, which ever is less.</p> <p>b) Major injuries or accident causing 25% or more permanent disablement to workmen or employees:</p>		
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	<p>Penalty @2.5% of contract value or Rs. 1,00,000/- per person which ever is less</p> <p>Permanent disablement shall have the same meaning as indicated in The Workmen's Compensation Act' 1923. The penalty mentioned above shall be in addition to the compensation payable to the workmen / employees under the relevant provisions of the Workmen's Compensation Act' 1923 and rules framed there under or any other applicable laws as applicable from time to time.</p> <p>III If any contractor worker found working without using the safety equipment like safety helmet, safety shoes, safety belts, etc. or without anchoring the safety belts while working at height the Engineer I/c / Safety Officer of NTPC shall have the right to penalize the contractor for Rs. 200/- per person per day and such worker shall be sent out of the workplace immediately and shall not be allowed to work on that day. Engineer I/c / Safety Officer of NTPC will also issue a notice in this regard to the contractor.</p> <p>IV If two or more fatal accidents occur at same NTPC site under the control of contractor during the period of contract and he has</p> <p>(1) not complied with keeping adequate PPEs in stock or</p> <p>(2) defaulted in providing PPEs to his workmen</p> <p>(3) not followed statutory requirements / NTPC safety rules</p> <p>(4) been issued warning notice/s by NTPC head of the project on non observance of safety norms</p> <p>(5) not provided safety training to all his workmen, the contractor can be debarred from getting tender documents in NTPC for two years from the date of last accident.</p> <p>The safety performance will also be one of the overriding criteria for evaluation of overall performance of the contractors by NTPC. The contractor shall submit the accident data including fatal / non-fatal accidents for the last 3 years where he has undertaken the construction activities Projects-wise along with the tender documents. This will also be considered for evolution of tender documents. If the information given by the contractor found incorrect, his contract will be liable to be terminated.</p>			
44.20.00	The Contractor will make available minimum quantity of all safety equipments and safety PPEs of required specifications as per suggestive list included bidding documents as a part of "List of minimum T & P". Further Contractor will ensure availabilitly of additional requirement for individual worker and safety equipment as per site requirement during execution of the contract till its completion.			
44.21.00	The Contractor shall abide by the following during Construction and Erection activities:			
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	<p>I. Chain pulley block shall not be used for loads more than 2 (Two) tonne. II. Hydra shall not be used for material transport. III. Cage shall necessarily be provided to Monkey ladders of height more than 4 m. IV. Fencing shall be provided to all Electrical Distribution boards and transformers etc.</p>			
44.21.00	<p>Award</p> <p>If the Contractor's performance on safety front is found satisfactory i.e. without any fatal/reportable accident in the year of consideration; he may be considered for suitable award "ACCIDENT FREE SAFETY MERITORIOUS AWARD" as per scheme of the employer.</p>			
45.00.00	<p>FOREIGN PERSONNEL</p>			
45.01.00	<p>The Contractor shall submit to the Employer data on all personnel he proposes to bring into India from abroad for the performance of the Works under the Contract, at least sixty (60) days prior to their departure to India. Such data will include for each person the name, his present address, his assignment and responsibility in connection with the works, and a short resume of his qualification, experience etc. in relation to the work to be performed by him.</p>			
45.02.00	<p>Any person unsuitable and unacceptable to the Employer shall not be brought to India. Any person brought to India, if found unsuitable or unacceptable by the Employer, the Contractor shall within a reasonable time make alternate arrangements for providing a suitable replacement and repatriation of such unsuitable personnel.</p>			
45.03.00	<p>No person brought to India for the purposes of the works shall be repatriated without the consent of the Employer in writing, based on a written request from the Contractor for such repatriation giving reasons for such an action to the Employer. The Employer may give permission for such repatriation provided he is satisfied that the progress of work will not suffer due to such repatriation.</p>			
45.04.00	<p>The cost of passports, visas and all other travel expenses to and from India, incurred by the Contractor shall be to his account. The Employer will not provide any residential accommodation and/or furniture for any of the Contractor's personnel including foreign personnel and Contractor shall make his own arrangements for such facilities in the area allotted at Site, to him by the Employer for that purpose.</p>			
45.05.00	<p>The Contractor and his expatriate personnel shall respect all Indian Acts, Laws, rules and regulations and shall not in any way interfere with Indian political and religious affairs and shall conform to any other rules and regulations which the Government of India and the Employer may establish from time to time, on them. The Contractor's expatriate personnel shall work and live in close co-operation and coordination with their co-workers and the community and shall not engage themselves in any other employment neither part-time or full-time nor shall they take part in any local politics.</p>			
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45.06.00	The Employer shall assist the Contractor, to the extent possible, in obtaining necessary permits to travel to India and back, by issue of necessary certificates and other information needed by the Government agencies.	
46.00.00	FOUNDATION DRESSING & GROUTING FOR EQUIPMENT/ EQUIPMENT BASES	
46.01.00	The surfaces of foundations shall be dressed to bring the top surface of the foundations to the required level, prior to placement of equipment/equipment bases on the foundations.	
46.02.00	All the equipment/ equipment bases, shall be grouted and finished by bidder as per these specifications unless otherwise recommended by the equipment manufacturer.	
46.03.00	The concrete foundation surfaces shall be properly prepared by bidder by chipping, grinding as required to bring the top of such foundation to the required level, to provide the necessary roughness for bondage and to assure enough bearing strength.	
46.04.00	<p>Grout</p> <p>The grout for equipment foundation shall be high strength grout having a minimum characteristic compressive strength of 60 N/mm² at 28 days. The grout shall be ready mix non-shrink, chloride - free, cement based, free flowing, non-metallic grout as recommended by equipment manufacturer. The ready mix grout shall be of reputed make as approved by the Employer.</p> <p>The Grout shall have good flowability even at very low water/ grout powder ratio.</p> <p>The Grout shall have characteristics of controlled expansion to be able to occupy its original volume to fill the voids and to compensate for shrinkage. Grout shall be of pre-mix variety so that only water needs to be added before use.</p> <p>The mixing of the Grout shall conform to the recommendations of the manufacturer of the Grout.</p>	
46.05.00	Placing of Grout	
46.05.01	After the base has been prepared, its alignment and level has been checked and approved and before actually placing the grout, a low dam shall be set around the base at a distance that will permit pouring and manipulation of the grout. The height of such dam shall be at least 25mm above the bottom of the base. Suitable size and number of chains shall be introduced under the base before placing the grout, so that such chains can be moved back & forth to push the grout into every part of the space under the base.	
46.05.02	The grout shall be poured either through grout holes if provided or shall be poured at one side or at two adjacent sides to make the grout move in a solid mass under the base and out in the opposite side. Pouring shall be continued until the entire space below the base is thoroughly filled and the grout stands at least 25 mm higher all	
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46.05.03	around than the bottom of the base. Enough care should be taken to avoid any air or water pockets beneath the bases.		
46.05.03	In addition to the above, recommendations of Grout manufacturer shall also be followed.		
46.06.00	Finishing of the Edges of the Grout		
	The poured grout should be allowed to stand undisturbed until it is well set. Immediately thereafter, the dam shall be removed and grout which extends beyond the edges of the structural or equipment base plates shall be cut off, flushed and removed. The edges of the grout shall then be pointed and finished with 1:2 cement mortar pressed firmly to bond with the body of the grout and smoothened with a tool to present a smooth vertical surface. The work shall be done in a clean and scientific manner and the adjacent floor spaces, exposed edges of the foundations, and structural steel and equipment base plates shall be thoroughly cleaned of any spillage of the grout.		
46.07.00	Checking of Equipment After Grouting		
	After the grout is set and cured, the Contractor shall check and verify the alignment of equipments, alignment of shafts of rotating machinery, the slopes of all bearing pedestals, centering of rotors with respect to their sealing bores, couplings, etc. as applicable and the like items to ensure that no displacement had taken place during grouting. The values recorded prior to grouting shall be used during such post grouting check- up and verifications. Such pre and post grout records of alignment details shall be maintained by the Contractor in a manner acceptable to the Employer.		
47.00.00	SHAFT ALIGNMENTS		
	All the shafts of rotating equipment shall be properly aligned to those of the matching equipments to as perfect an accuracy as practicable. The equipment shall be free from excessive vibration so as to avoid overheating of bearings or other conditions which may tend to shorten the life of the equipment. The vibration level of rotating equipments measured at bearing housing shall conform to Zone A of ISO 10816. All bearings, shafts and other rotating parts shall be thoroughly cleaned and suitably lubricated before starting.		
48.00.00	DOWELLING		
	All the motors and other equipment shall be suitably doweled after alignment of shafts with tapered machined dowels as per the direction of the Employer.		
49.00.00	CHECK OUT OF CONTROL SYSTEMS		
	After completion of wiring, cabling furnished under separate specification and laid and terminated by the Employer, the Contractor shall check out the operation of all control systems for the equipment furnished and installed under these specifications and documents.		
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50.00.00	COMMISSIONING SPARES	
50.01.00	It will be the responsibility of the Contractor to provide all commissioning spares including consumable spares required for initial operation till the Completion of Facilities. The Contractor shall furnish a list of all commissioning spares within 60 days from the date of Notification of Award and such list shall be reviewed by the Employer and mutually agreed to. However, such review and agreement will not absolve the Contractor of his responsibilities to supply all commissioning spares so that initial operation do not suffer for want of commissioning spares. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Employer.	
50.02.00	These spare will be received and stored by the Contractor atleast 3 months prior to the schedule date of commencement of initial operation of the respective equipment and utilised as and when required. The unutilised spares and replaced parts, if any, at the end of successful completion of guarantee tests shall be the property of the Contractor and he will be allowed to take these parts back at his own cost with the permission of Employer.	
51.00.00	CABLING	
51.01.00	All cables shall be supported by conduits or cable tray run in air or in cable channels. These shall be installed in exposed runs parallel or perpendicular to dominant surfaces with right angle turn made of symmetrical bends or fittings. When cables are run on cable trays, they shall be clamped at a minimum intervals of 2000mm or otherwise as directed by the Employer.	
51.02.00	Each cable, whether power or control, shall be provided with a metallic or plastic tag of an approved type, bearing a cable reference number indicated in the cable and conduit list (prepared by the Contractor), at every 5 meter run or part thereof and at both ends of the cable adjacent to the terminations. Cable routing is to be done in such a way that cables are accessible for any maintenance and for easy identification.	
51.03.00	Sharp bending and kinking of cables shall be avoided. The minimum radii for PVC insulated cables 1100 V grade shall be 15 D where D is the overall diameter of the cable. Installation of other cables like high voltage, coaxial, screened, compensating, mineral insulated shall be in accordance with the cable manufacturer's recommendations. Wherever cables cross roads and water, oil, sewage or gaslines, special care should be taken for the protection of the cables in designing the cable channels.	
51.04.00	In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop fault at a later date.	
51.05.00	Control cable terminations shall be made in accordance with wiring diagrams, using identifying codes subject to the Employer's approval. Multicore control cable jackets shall be removed as required to train and terminate the conductors. The cable jacket shall be left on the cable, as far as possible, to the point of the first conductor branch. The insulated conductors from which the jacket is removed shall be neatly	
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51.06.00	twined in bundles and terminated. The bundles shall be firmly but not tightly tied utilising plastic or nylon ties or specifically treated fungus protected cord made for this purpose. Control cable conductor insulation shall be securely and evenly cut.			
52.00.00	EQUIPMENT DELIVERY AND ERECTION			
52.01.00	General Requirements			
	(a.) This part covers Contractor's responsibilities for packing, shipping, warehousing and the installation of all equipment and materials furnished and installed under this specification.			
	(b.) The Contractor shall submit for Employer's approval draft manual for Equipment Delivery and Erection (EDE Manual) covering detailed instructions, write up, technical data, drawings, check-lists, documentation formats for all activities after equipment manufacture upto installation of equipment. This manual shall cover general instructions for all equipment and specific instructions for individual equipment wherever required and shall include at least the following :			
	(1.) Instructions for packing, shipping, receiving handling, warehousing and storage.			
	(2.) Instructions for location and installation of equipment furnished by this specification.			
	(3.) Installation drawings for field mounted equipment, panels, cubicles and other equipment covered under this specification.			
	(4.) Instruction relating installation of piping/ tubing, support and routing drawings of impulse pipes/signal tubes and tube/cable trays.			
	(5.) Check lists and quality assurance hold points.			
	(6.) Format for all related documentation.			
	(c.) The EDE Manual shall conform to the requirements of this specification, all applicable codes and standards, recommendations of equipment manufacturers and accepted good engineering practices and shall be subject to Employer approval during detailed engineering.			
	(d.) The Contractor shall ensure that all work under this part shall be performed as per the requirements of this specification, Employer approved EDE			
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52.02.00	<p>Manual and drawing/documents approved by the Employer during detailed engg.</p> <p>Crating</p> <p>(a.) All equipment and materials shall be suitably coated, wrapped, or covered and boxed or crated for moist humid tropical shipment and to prevent damage or deterioration during handling and storage at the site.</p> <p>(b.) Equipment shall be packed with suitable desiccants, sealed in water proof vapour-proof wrapping and packed in lumber of plywood enclosures, suitably braced, tied and skidded. Lumber enclosures shall be solid, not slatted.</p> <p>(c.) Desiccants shall be either silica gel or calcium sulphate, sufficiently ground to provide the required surface area and activated prior to placing in the packaging. Calcium sulphate desiccants shall be of a chemical nature to absorb moisture. In any case, the desiccant shall not be of a type that will absorb enough moisture to go into solution. Desiccants shall be packed in porous containers, strong enough to withstand handling encountered during normal shipment. Enough desiccant shall be used for the volumes enclosed in wrapping.</p> <p>(d.) Review by the Employer of the Contractor's proposed packaging methods shall not relieve the Contractor of responsibility for damage or deterioration to the equipment and materials specified.</p> <p>(e.) All accessory items shall be shipped with the equipment. ; Boxes and crates containing accessory items shall be marked so that they are identified with the main equipment. The contents of each box and crates shall be indicated by markings on the exterior.</p> <p>(f.) All boxes, crates, cases bundles, loose pieces, etc. shall be marked consecutively from No.1 upward throughout all shipments from a given port to completion of the order without repeating the same number.</p> <p>(g.) An itemized list of contents shall be enclosed inside each case and one other copy securely fastened to the outside of the case in a tin or light weight sheet metal envelope or pocket. The lists shall be plainly marked and placed in accessible locations to facilitate receipt and inspection. The packing list shall indicate whether shipment is partial or complete and shall incorporate the following information on each container, etc., according to its individual shipping number :</p> <p>a) Export case markings</p> <p>b) Case number</p> <p>c) Gross weight and net weight in Kilograms</p> <p>d) Dimensions in centimeters</p> <p>e) Complete description of material</p>		
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52.03.00	<p>(h.) Packaging or shipping units shall be designed within the limitations of unloading facilities and the equipment which will be used for transport. Complications involved with ocean shipment and the limitations of ports, railways and roads shall be considered. It shall be the Contractor's responsibility to investigate these limitations and to provide suitable packaging to permit safe handling during transit and at the job site.</p> <p>(i.) Electrical equipment, control and instrumentation shall be protected against moisture and water damage. All external gasket surfaces and flange faces, couplings, motor pump shafts, bearing and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection.</p> <p>(j.) Equipment having antifriction or sleeve bearings shall be protected by weather tight enclosures.</p> <p>(k.) Coated surfaces shall be protected against impact, abrasion, discolouration and other damage. Surfaces which are damaged shall be repaired.</p> <p>(l.) All exposed threaded parts shall be greased and protected with metallic or other substantial type protectors. All female threaded openings shall be closed with forged steel plugs. All pipings, tubing, and conduit equipment and other equipment openings shall be sealed with metallic or other rough usage covers and tapped to seal the interior of the equipment piping, tubing, or conduit.</p> <p>(m.) Provisions shall be made to ensure that water does not enter any equipment during shipment or in storage at the plant site.</p> <p>(n.) Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.</p> <p>(o.) While packaging the material, care shall be taken for the limitation from the point of view of availability of railway wagon sizes in India.</p>		
	<p>Factory Assembly</p> <p>(a.) Instrument enclosures shall be supplied and erected completely in the factory with instrument, air supply and blow down piping with necessary valves, fittings, etc. and also all electrical wiring between the instruments and the enclosure terminal blocks. Control panel and cubicles shall also be fully wired in the factory. Control panel mounted equipments are to be dismounted from the panels before shipment and individually packed for shipment. Electronic control modules of the plug-in type are to be removed from equipment racks after factory checkout are individually packed for shipment. Other equipment shall be fully assembled at the factory, except for necessary shipping splits in panels.</p>		
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52.04.00	<p>(b.) All separately packaged accessories items and parts shall be shipped with the equipment. Containers for separately packaged items shall be marked so that they are identified with the main equipment. An itemized packing slip, indicating what is in that carton only, shall be attached to the outside and inside of each container used for packing.</p> <p>A master packing slip covering all accessories items for a given piece of equipment which are shipped in separate containers, shall be attached to one container.</p> <p>Equipment Installation</p> <p>(a.) General Requirements</p> <p>(1.) The Contractor shall furnish all construction materials, tools and equipment and shall perform all work required for complete installation of all control and instrument equipment furnished under this specification.</p> <p>(2.) Contractor shall prepare detailed installation drawings for each equipment furnished under this specification for Employer's approval. Installation of all equipment/systems furnished by this specification shall be as per Employer's approval.</p> <p>(3.) Erection procedures not specified herein shall be in accordance with the recommendations of the equipment manufacturers. The procedures shall be acceptable to the Employer.</p> <p>(4.) The Contractor shall coordinate his work with other suppliers where their instruments and devices are to be installed under specifications.</p> <p>(b.) Installation Materials</p> <p>All materials required for installation, testing and commissioning of the equipment shall be furnished by the Contractor.</p> <p>(c.) Regulatory Requirements</p> <p>All installation procedures shall confirm with the accepted good engineering practice and with all applicable governmental laws, regulations and codes.</p> <p>(d.) Cleaning</p> <p>All equipment shall be cleaned of all sand, dirt and other foreign materials immediately after removal from storage and before the equipment is brought inside the power plant building or to other installation sites. All piping and tubes shall be air blown.</p> <p>(e.) Equipment Assembly</p> <p>Equipment installed under these specifications shall be assembled if shipped unassembled. The equipment shall be dismantled and reassembled as</p>		
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	<p>required to perform the installation and commissioning work described in these specifications.</p> <p>(f.) Equipment Setting</p> <p>Field mounted instruments and accessories shall be bracket or sub panel mounted on the nearest suitable firm steel work or masonry. The brackets, stands, supports and other miscellaneous hardware required for mounting instruments and accessories such as receiver gauge, air set, valve manifold, purge-meter etc. shall be furnished and installed. No field mounted instruments shall be installed such that it depends for support or rigidity on the impulse piping or on electrical connection to it.</p> <p>Indicating type field mounted instruments shall be installed in such a way that centre of indicating dial shall be about 1600-1800mm from operating floor level. Non-indicating type field instruments shall be installed such that operating handle of manifold block / isolating cock comes within 1600 mm from operating floor level.</p> <p>(g.) Free-Standing Equipment</p> <p>Free-standing Cabinets shall be attached to the floor, concrete equipment bases or supporting steel as indicated on the manufacturer's drawings and the Employer's Plant Arrangement Drawings. The cabinets shall be shimmed for proper alignment before bolting them to the floor. Adjacent enclosures shall be shimmed to maintain mutually level appearance before they are attached to floor. Vibration dampening mounts shall be installed between supporting structures and panels when specified.</p> <p>(h.) Non-free Standing Equipment</p> <p>(1.) Non-free standing local enclosures and cabinets shall be mounted in accessible locations on columns, walls, or stands in locations as indicated on the Employer's Plant Arrangement Drawings. Bracket and stands shall be fabricated as required to install the local enclosures and cabinets in a workman like manner.</p> <p>(2.) Rough edges and welds on all fabricated supports shall be ground smooth. The supports shall be finished with two coats of primer and two coats of paint as specified in this part.</p> <p>(i.) Equipment Location</p> <p>(1.) All individual items of equipment not located in cabinets or on panels and racks are located approximately according to the floor elevation and the nearest building column designated by the Employer.</p> <p>(2.) Solenoid valves not located in enclosures or mounted on valves shall be mounted in easily accessible protected locations near the components with which they are associated.</p>		
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	<div><div><div>(3.) All brackets, stands, supports and other miscellaneous hardware required for mounting devices shall be furnished and installed.</div><div>(4.) Thermometers shall be installed in the process lines and ducts as required and adjusted for ease in reading.</div><div>(5.) Permanent temperature wells on the main steam, hot reheat and cold reheat piping shall not be installed until steam blowing has been completed. Temporary temperature wells shall be installed in the main and reheat steam piping during steam blow and discarded after completion.</div><div>(6.) Any required adapting hardware such as pipe bushings, nipples, drilled caps and the like shall be provided for complete installation of control devices into process connections.</div></div><div>For location of C&I related equipment/devices, the requirement specified elsewhere in the technical specification may be referred.</div><div><div>(j.) Installation of Field Mounted Instruments and Devices</div><div>The Contractor shall submit installation drawings for all field mounted equipment furnished under this specification for Employer's approval. These drawings shall meet the requirements of this specification, installation drawings, applicable codes and standards and recommendations of manufacturers of instruments/devices. All installation work under this specification shall be strictly as per installation drawings approved by the Employer during detailed engineering stage.</div><div>In addition to above relevant Portion as specified elsewhere in technical specification may be referred.</div><div><div>(k.) Piping Connections</div><div><div>(1.) All equipment having piping connections shall be levelled, aligned and wedged in place but shall not be grouted or bolted prior to the initial fitting and alignment of connecting piping. All equipment shall, however, be grouted or bolted to its foundation prior to final bolting or welding of the connection piping.</div><div>(2.) All flanged joints shall be checked and retightened after approximately 10 days of operation at normal operating temperature.</div></div><div><div>(l.) Equipment Checkout</div><div><div>(1.) All equipment shall be cleaned after installation. Equipment subject to pressure differentials shall be checked for leakage.</div><div>(2.) After erection, all equipment having moving parts, having electrical apparatus, or subject to pressure differentials shall be trial-operated.</div></div></div></div></div></div>			
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	<p>(m.) Defects</p> <p>(1.) All defects in erection shall be corrected to the satisfaction of the Employer and the Project Manager. The dismantling and reassembly of Contractor furnished equipment to remove defective parts, replace parts, or make adjustments shall be included as a part of the work under these specifications.</p> <p>(2.) The removal of control and instrument equipment in order to allow bench calibration, if required, and the re-installation of the said equipment after calibration shall also be included as a part of the work under these specifications.</p> <p>(n.) Equipment Protection</p> <p>(1.) All equipment to be erected under these specifications shall be protected from damage of any kind from the time of contract award until commissioning of each unit.</p> <p>(2.) The equipment shall be protected during storage as described herein.</p> <p>(3.) Equipment shall be protected from weld spatter during construction.</p> <p>(4.) Suitable guards shall be provided for protection of personnel on all exposed rotating or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy removal and maintenance.</p> <p>(5.) Equipment having glass components such as gauges, or equipment having other easily breakable components, shall be protected during the construction period with plywood enclosures or other suitable means. Broken, stolen, or lost components shall be replaced by the Contractor.</p> <p>(6.) Machine finished surfaces, polished surfaces, or other bare metal surfaces which are not to be painted, such as machinery shafts and couplings shall be provided temporary protection during storage and constructional periods by a coating of a suitable non- drying, oily type, rust preventive compound.</p>		
53.00.00	<p>WELDING - SPECIAL REQUIREMENTS</p> <p>If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be performed under separate specifications, the requirements shall be submitted to the Project Manager in advance of commencement of erection work.</p>		
54.00.00	<p>DEVIATIONS DISPOSITIONING:</p> <p>Any deviation to the contract and employer approved documents shall be properly recorded in the format prescribed by NTPC. All the deviations shall be brought to the knowledge of employer's representative for suitable dispositioning.</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)		TECHNICAL SPECIFICATION SECTION – VI, PART-D BID DOC. NO CS-9858-001-02	ERECTION CONDITIONS OF CONTRACT PAGE 44 OF 53



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55.00.00	NON-DESTRUCTIVE TESTING (NDT): The contractor shall record results of NDTs carried out at site in the format acceptable to employer. All the radiographs & its report duly signed & correlated to the job shall be handed over to the employer. Sensitivity of all the test equipment shall be compatible to the job & acceptance norms agreed.		
56.00.00	TESTING EQUIPMENT & FACILITIES: Contractor shall provide the testing equipment and facilities necessary to carry out tests & inspections.		
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ANNEXURE-I

STANDARD CHECKLIST

COMMISSIONING/TESTING ESSENTIAL PRE-REQUISITE

1. MECHANICAL

(A.) VALVES

- (1.) MANUALLY OPERATED VALVE
- (2.) ELECTRICALLY OPERATED VALVE
- (3.) PNEUMATICALLY ACTUATED VALVE
- (4.) HYDRAULICALLY ACTUATED VALVE
- (5.) SAFETY VALVE
- (6.) ELECTROMATIC RELIEF VALVE
- (7.) STEAM TRAP
- (8.) BUTTERFLY VALVE(ELECTRICALLY OPERATED)
- (9.) BUTTERFLY VALVE (MANUALLY OPERATED)
- (10.) BUTTERFLY VALVE(FOUR WAY-ELECTRICAL)
- (11.) NON-RETURN VALVE(INCLUDING HYDRAULIC/PNEUMATIC FCNRVS)
- (12.) THREE WAY CONTROL VALVE
- (13.) RELIEF VALVE
- (14.) DIFFERENTIAL PRESSURE REGULATING VALVE
- (15.) FLOAT OPERATED VALVES

(B.) TANKS AND PRESSURE VESSELS

- (1.) TANKS (METAL)UPTO 20 M2
- (2.) TANKS (LARGE STORAGE)
- (3.) PRESSURE VESSEL (BELOW 17 BARS)
- (4.) AIR RECEIVER
- (5.) PRESSURE VESSEL-ACCESS DOOR
- (6.) TURBINE MAIN OIL TANK




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	<p>(C.) PUMPS</p> <p>(1.) PUMP LOW PRESSURE CENTRIFUGAL (MOTOR DRIVEN)</p> <p>(2.) PUMP UP TO 350 HP (260 KW)</p> <p>(3.) PUMP SUMP INSTALLATION</p> <p>(4.) GEAR PUMP/SCREW PUMP</p> <p>(D.) PIPE WORK SYSTEM</p> <p>(1.) STEAM SERVICES</p> <p>(2.) WATER SERVICES</p> <p>(3.) OIL/FIRE RESISTANT FLUID SYSTEM</p> <p>(4.) AIR SERVICES (COMPRESSOR)</p> <p>(5.) HIGH PRESSURE SERVICES</p> <p>(6.) CONSTANT LOAD SUPPORT</p> <p>(7.) SPRING SUPPORTS</p> <p>(8.) HANGERS AND OTHER SUPPORTS</p> <p>(E.) STRAINER AND FILTER</p> <p>(1.) STRAINER/FILTER BASKET TYPE</p> <p>(2.) STRAINER ROTARY (LOW PRESSURE)</p> <p>(3.) FILTER & STRAINERS CENTRIFUGAL SEPARATORS</p> <p>(4.) FILTER & STRAINER Y-TYPE</p> <p>(5.) FILTER & STRAINER (PLATE TYPE)</p> <p>(6.) PURIFIER</p> <p>(7.) FILTER-COMPRESSED AIR LINE</p> <p>(F.) HEAT EXCHANGER</p> <p>(1.) HEAT EXCHANGER (GENERAL)</p> <p>(2.) HEAT EXCHANGER-OIL/WATER</p> <p>(3.) ROTARY AIR HEATER</p> <p>(G.) FANS AND COMPRESSORS</p> <p>(1.) FANS-NON-PRESSURE LUBRICATED</p>	
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	<p>(2.) FANS-AXIAL FLOW PRESSURE LUBRICATED</p> <p>(3.) COMPRESSORS-GENERAL</p> <p>(4,) DAMPERS & GATES</p> <p>(H.) CRANES AND ELEVATORS</p> <p>(1.) AUXILIARY OVERHEAD CRANE</p> <p>(2.) TRAVEL SUPPORT STRUCTURE FOR CRANE</p> <p>(3.) LONG TRAVEL & CROSS TRAVERSE MOTION OF CRANE</p> <p>(4.) MAIN AUX. HOIST MOTION (CRANE)</p> <p>(5.) ELECTRIC HOIST</p> <p>(I.) POWER TRANSMISSION</p> <p>(1.) POWER TRANSMISSION GEAR BOX</p> <p>(2.) BEARING</p> <p>(3.) FLUID COUPLINGS</p> <p>2. ELECTRICAL</p> <p>(1.) SWITCHYARD</p> <p>(2.) POWER TRANSFORMERS, LT INDOOR TRANSFORMERS, OUTDOOR TRANSFORMERS,</p> <p>(3.) BATTERY CHARGERS, DC BATTERIES, DG SETS, STATION LIGHTING, OVERHEAD LINES.</p> <p>(4.) MV BUS DUCTS</p> <p>(5.) D.C. MOTOR</p> <p>(6.) HV SQUIRREL CAGE INDUCTION MOTOR</p> <p>(7.) 415 V SQUIRREL CAGE INDUCTION MOTOR</p> <p>(8.) MOTOR OPERATED ACTUATORS</p> <p>(9.) LT SWITCHGEARS/MCC</p> <p>(I.) STANDARD CHECLISTS FOR ALL TYPES OF RELAYS USED IN SWITCHGEARS PROTECTION SYSTEM</p> <p>(II.) PT CARRIAGE AND CUBICLES</p> <p>(III.) CABLE/BUS DUCT/BUS BARS</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATION SECTION – VI, PART-D BID DOC. NO CS-9858-001-02	ERECTION CONDITIONS OF CONTRACT	PAGE 48 OF 53	




CLAUSE NO.	ERECTION CONDITIONS OF CONTRACT		
3.	<div> <div>(IV.) CONTRACTOR MODULE</div> <div>(V.) SWITCH FUSE MODULE</div> <div>(VI.) MASTER PANEL OF LUBE OIL PANEL</div> <div>(VII.) FEEDER PANEL OF LUBE OIL PANEL</div> <div>(VIII.) SPACE HEATER AND CABLE MODULE</div> <div>(IX.) CONTROL TRANSFORMER MODULE</div> <div>(X.) HT CIRCUIT BREAKER</div> <div>(XI.) 415 V CIRCUIT BREAKER</div> <div>(10.) POWER CABLE</div> <div>(11.) CONTROL CABLE</div> <div>(12.) AUXILIARY CABLE</div> <div>(13.) D.C. CABLE</div> <div>(14.) EXPLOSION PROOF ELECTRICAL EQUIPMENT</div> <div>(15.) JUNCTION BOX</div> <div>(16.) CONTROL TRANSFORMER MODULE</div> <div>(17.) BRUSH GEAR ASSEMBLY</div> <div>(18.) AUX. CONTROL AND RELAY PANEL DESK</div> <div>(19.) INDICATING INSTRUMENT</div> <div>(20.) RECORDING INSTRUMENT</div> <div>(21.) INTEGRATING INSTRUMENT</div> </div>		
	<div> <div>CONTROL & INSTRUMENTATION</div> <div>(A.) CONDUCTIVITY ANALYSING EQUIPMENT INCLUDING TEST PROCEDURES</div> <div>(B.) PH ANALYSER INCLUDING TEST PROCEDURE</div> <div>(C.) SILICA ANALYSER</div> <div>(D.) LEVEL SWITCH (FLOAT ACTUATED)</div> <div>(E.) LEVEL SWITCH (ELECTRODE TYPE)</div> <div>(F.) LEVEL SWITCH (DISPLACER ACTUATED)</div> </div>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)		TECHNICAL SPECIFICATION SECTION – VI, PART-D BID DOC. NO CS-9858-001-02	ERECTION CONDITIONS OF CONTRACT PAGE 49 OF 53



CLAUSE NO.	ERECTION CONDITIONS OF CONTRACT			
	<div><div>(G.)</div><div>TRANSMITTER (FLOAT OPERATED PNEUMATIC OUTPUT) INCLUDING TESTING PROCEDURE</div></div> <div><div>(H.)</div><div>LEVEL INDICATOR (FLOAT/PULLEY TYPE)</div></div> <div><div>(I.)</div><div>LOCAL TEMPERATURE INDICATORS INCLUDING TEST PROCEDURE</div></div> <div><div>(J.)</div><div>RESISTANCE THERMOMETER ELEMENT INCLUDING TEST PROCEDURE</div></div> <div><div>(K.)</div><div>THERMOCOUPLE ELEMENT AND CONNECTING CABLE</div></div> <div><div>(L.)</div><div>THERMOCOUPLE AND RESISTANCE THERMOMETER CONVERTOR/TRANSMITTER INCLUDING TEST PROCEDURES.</div></div> <div><div>(M.)</div><div>TEMPERATURE SWITCH/THERMOSTAT INCLUDING TEST PROCEDURES</div></div> <div><div>(N.)</div><div>COLD JUNCTION BOXES</div></div> <div><div>(O.)</div><div>ZENER BARRIER</div></div> <div><div>(P.)</div><div>O2 ANALYSER</div></div> <div><div>(Q.)</div><div>O2 IN HYDROGEN INCLUDING TEST PROCEDURES</div></div> <div><div>(R.)</div><div>PRESSURE AND VACUUM GAUGE</div></div> <div><div>(S.)</div><div>PRESSURE AND VACUUM SWITCH INCLUDING TEST PROCEDURE</div></div> <div><div>(T.)</div><div>DIFFERENTIAL PRESSURE TRANSMITTER INCLUDING TEST PROCEDURE</div></div> <div><div>(U.)</div><div>DIFFERENTIAL PRESSURE SWITCH INCLUDING TEST PROCEDURE.</div></div> <div><div>(V.)</div><div>FLOW INDICATOR (VARIABLE AREA)</div></div> <div><div>(W.)</div><div>ORIFICE PLATE</div></div> <div><div>(X.)</div><div>TURBINE FLOW TRANSMITTER</div></div> <div><div>(I.)</div><div>FLOW SWITCH</div></div> <div><div>(II.)</div><div>WEIR</div></div> <div><div>(III.)</div><div>NOZZLE</div></div> <div><div>(IV.)</div><div>FLOW INDICATOR (PNEUMATIC INPUT) INCLUDING TEST PROCEDURE</div></div> <div><div>(V.)</div><div>FLOW INTEGRATOR (PNEUMATIC INPUT)INCLUDING TESTPROCEDURE</div></div> <div><div>(VI.)</div><div>FLOW INDICATOR (FLOAT OPERATED) INCLUDING TEST PROCEDURE</div></div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)		TECHNICAL SPECIFICATION SECTION – VI, PART-D BID DOC. NO CS-9858-001-02	ERECTION CONDITIONS OF CONTRACT	PAGE 50 OF 53



CLAUSE NO.	ERECTION CONDITIONS OF CONTRACT			
	<div>(VII.) VENTURI (FLUID)</div> <div>(VIII.) FLOW SWITCH (MAGNETIC TYPE)</div> <div>(IX.) AVERAGING INLET</div> <div>(X.) LIMIT SWITCHES</div> <div>(Y.) TURBINE SUPERVISORY MEASURING SYSTEM</div> <div>(Z.) POSITION MEASUREMENT AND INDICATION INCLUDING TEST PROCEDURES</div> <div>(AA.) TACHOMETER</div> <div>(BB.) VIBRATION MEASUREMENT</div> <div>(CC.) DIGITAL INDICATOR</div> <div>(DD.) MOVING COIL INDICATOR INCLUDING TEST PROCEDURE</div> <div>(EE.) RECORDER INCLUDING TEST PROCEDURE</div> <div>(FF.) FLAME SCANNER</div> <div>(GG.) ELECTRICAL AUTO MANUAL CONTROL STATION</div> <div>(HH.) PUSH BUTTON MODULE</div> <div>(II.) ALARM ANNUNCIATOR EQUIPMENT INCLUDING TEST PRO</div> <div>(JJ.) TEST PROCEDURE FOR ELECTRONIC MODULES OF DDCMIS</div> <div>KK.) THERMO CONTROL VALVE</div> <div>(LL.) TEST PROCEDURE FOR ADJUSTMENT OF MODULATING CONTROLLER - PID TERMS</div> <div>(MM.) TEST PROCEDURE INDICATING CONTROLLER-ELECTRICAL INPUT AND PNEUMATIC OUTPUT</div> <div>Note: The items which are not part of this specification may be considered as not applicable.</div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)		TECHNICAL SPECIFICATION SECTION – VI, PART-D BID DOC. NO CS-9858-001-02	ERECTION CONDITIONS OF CONTRACT	PAGE 51 OF 53



CLAUSE NO.	ERECTION CONDITIONS OF CONTRACT		
	<p style="text-align: right;">ANNEXURE-II</p> <p style="text-align: center;">BRIEF WRITE UP ON THE CONTENTS OF TESTING SCHEDULE / COMMISSIONING SCHEDULE</p> <p>Testing Schedules should be designed to ensure that the plant area, equipment or apparatus are tested and commissioned and will operate as per the employer's specifications and good engineering practices.</p> <p>Testing Schedule/Commissioning Schedule is required to be of a standard format in order to maintain consistency of presentation, content and reporting.</p> <p>Testing Schedule/Commissioning Schedule should contain the following sections to make the document a self contained one:</p> <ol style="list-style-type: none"> 1. Plant Details/Design data 2. Testing Objective/Proposals 3. State of the Plant <ol style="list-style-type: none"> a) Erection Status with respect to Mech. Elect and C&I b) Availability of the services required c) Safety requirements as per Manufacturer's 4. Test method including completion/acceptance criteria 5. Results 6. Appendix <ol style="list-style-type: none"> a) Testing Programme b) Mech/Elect/C&I -Plant item completing list c) List of Drawing/documents required for carrying out the testing. 		
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CLAUSE NO.	ERECTION CONDITIONS OF CONTRACT		
	<p style="text-align: right;">ANNEXURE - III</p> <p style="text-align: center;">SAFETY PLAN</p> <ol style="list-style-type: none"> 01. Safety Policy of the Contractor to be enclosed: 02. When was the Safety Policy last reviewed: 03. Details of implementation procedure / methods to implement Safety Policy / Safety Rules : 04. Name, Qualification, experience of Safety Officer 05. Review of Accidents Analysis Method, Methods to ensure Safety and Health: 06. Unit executive responsible to ensure Safety at various levels in work area: 07. List of employees trained in safety employed before execution of the job. Give the details of training: 08. Safety Training Targets, Schedules, methods Adopting to providing safety training to all employees: 09. Details of checklist for different jobs / work and responsible person to ensure compliance (copy of checklist to be enclosed): 10. Regular Safety Inspection Methods and Periodicity and list of members to be enclosed: 11. Risk Assessment, Safety Audit by Professional Agencies, Periodicity: 12. Implementation of Recommendations of Audit / Inspections. Procedures for implementation and follow up: 13. Provision for treatment of injured persons at work site: 14. Review of overall safety by top Management and Periodicity: 15. System for Implementation of Statutory legislations: 16. Issue of PPEs to employees, Periodicity / stock on hand etc: <p style="text-align: right;">Signature Head of the Organisation with date & stamp</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATION SECTION – VI, PART-D BID DOC. NO CS-9858-001-02	ERECTION CONDITIONS OF CONTRACT	PAGE 53 OF 53

SUB-SECTION – B-14

SWITCHYARD




CLAUSE NO.	TECHNICAL REQUIREMENTS			
CHAPTER: SWITCHYARD ELECTRICAL				
1.00.00	SCOPE AND GENERAL INFORMATION			
1.01.00	The Voltage level for the Switchyard shall be as per Single Line Diagram. In addition to the detailed scope and other requirements specified in Part-A, the intent of the specifications for various electrical equipments shall also cover the following scope:			
1.01.01	Contractor shall be responsible for design and engineering of overall system/station, and all elements, systems, sub-systems, facilities, equipments, material, etc. The Contractor shall submit design calculations, drawings, codes, codes of practices, construction drawings, etc. for Employer's approval.			
1.01.02	The basic design shall include, but not limited to, the following:			
	<div>a) Development of general arrangement.</div> <div>b) Development of detailed layout (plan & section/elevation) drawings.</div> <div>c) Development of single line diagram with parameters of equipment and details of protection.</div> <div>d) Protection and control philosophy and selection of protection, control and annunciation schemes.</div> <div>e) Development of interlocking schemes.</div> <div>f) Development of switchyard structure loading details.</div> <div>g) Development of earthing system.</div> <div>h) Development of direct stroke lightning protection system.</div> <div>i) Insulation coordination of the EHV equipment.</div> <div>j) Calculation of static and dynamic force load, and selection of spacer spans and equipment terminal loading.</div> <div>k) Development of clearance diagrams.</div> <div>l) Lighting design, Lux level calculation and conduit wiring diagram.</div> <div>m) Development of power & control cable laying and termination schedules.</div> <div>n) Relay setting calculations.</div> <div>o) Development of erection key diagram with bill of material.</div> <div>p) Foundation design and construction drawings.</div> <div>q) Development of cable trench layout and sections and construction drawings.</div>			
1.01.03	Contractor shall furnish detailed drawings for the various equipments covered in their scope for Employer's approval.			
1.01.04	Exposed live parts shall be placed high enough above ground to meet the requirements of Indian Electricity Rules and other statutory codes. All responsibilities regarding co-ordination with Electrical Inspection Agencies and obtaining clearance certificate from them rests with the Contractor. The necessary fees for such clearances shall be borne by the Owner.			
1.01.05	All equipment shall be supplied with suitable terminal connectors. The terminal connector shall be well coordinated with the rating/type/size of conductor and equipment to be connected. The conductor terminations for equipment shall be either rigid or expansion type suitable for tube or horizontal or vertical take off suitable for quad/ Twin conductor. The spacing for quadruple and twin conductor shall be 450 mm for 765kV, 400kV & 220kV and spacing for twin conductor shall be 250 mm for 132kV. The type of terminal clamps would be finalised by the Contractor in			
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CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
	consultation with Employer based on layout requirement. The terminal pads shall preferably be capable of taking the required conductor span under normal, short circuit and meteorological conditions, without effecting the performance of the equipment.		
1.01.06	The rigid busbars for equipment inter connections shall have rigid connections at one end and expansion /flexible at other end. The tubular Al. connections shall have not more than one joint per span. Corona Bell shall be provided at the end of the rigid busbars.		
1.01.07	The line take off arrangement from GIS building up to line take off gantry shall be through GIS ducts as indicated in Single line diagram. The line side insulators and hardwares shall be provided by the line contractor, however the clamps and connectors for droppers to equipments are in the bidders scope. Location of line take off gantry and intermediate gantry (as required) for termination of Transmission line dead end tower to switchyard shall be finalized during detailed engineering based on the technical requirements. . All the terminations shall be done as indicated in the Single line diagram. High speed earth switches shall be provided wherever required.		
1.01.08	<p>The minimum sizing criteria of the control room and GIS building shall be as given below:</p> <p>The GIS building shall be adequately designed so as have a passage of minimum 2.0 m on either side and adequate overhead clearance for the movement of equipments without any obstruction, from the top of the GIS equipment to EOT Crane. The GIS switchyard shall have a suitable Double storied Control Room Building with provision of Switchgear room, Battery room, charger room, office, cable vault, SAS room, Lab room, CRP Panel room, conference room, toilet etc.. The GIS & control room building is to be designed keeping future provision for extension if any as shown in the Single line diagram. <u>The GIS building shall have adequate provision for maintenance bay.</u></p>		
1.01.09	The EOT crane to be provided inside the GIS buildings and shall be suitable to move heaviest part for maintenance. The minimum capacity of EOT crane shall be 12.5T for 765kV, 6T for 400kV, 5T for 220kV & 132kV GIS buildings.		
1.01.10	The Contractor shall cooperate in all respects and exchange the necessary technical data/ drawings with other agencies and Employer's other Contractors under intimation to Employer to ensure proper coordination and completion of work in time.		
1.01.11	The sag tension, conductor spacing, short circuit forces, spacers location, conductor swing and clearances shall be carried out in accordance with IEC 60865 to achieve the specified clearances.		
1.01.12	All overhead stringing shall be carried out by minimum double tension string insulator assembly.		
1.01.13	Post insulators shall be provided at line entry and near transformers and other jumpers so as to avoid mechanical forces on the LA's and Bushings etc.		
1.01.14	Necessary fire wall shall be provided between single phases of reactors and transformers. The fire wall height shall be 600mm above reactor/ transformer bushing.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS																		
1.01. 15	The pit size of reactors and transformers shall be designed for minimum 1000mm beyond the physical dimension of the reactor.																		
1.01. 16	<p>The towers and gantries shall be suitable for a normal conductor tension of minimum 2T/conductor in case of twin/ single conductors and 1.5T/conductor in case of quad conductor. The foundations and structures etc shall be designed accordingly. The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment structure, where it rests on the foundation pad shall be 2550 mm. All gantries and towers (including intermediate/required for turning etc.) as required for GT O/H stringing on A-Row and line take off, are to be provided by the contractor.</p> <p>Various minimum heights of the AIS switchyard shall be as given below from plinth level:</p> <table><tr><th>Voltage level</th><th>Eqpt./1st level</th><th>Line take off gantry height</th></tr><tr><td>765 kV</td><td>14000mm</td><td>39000mm</td></tr><tr><td>400 kV</td><td>8000mm</td><td>23000mm</td></tr><tr><td>220kV</td><td>6000mm</td><td>17000mm</td></tr><tr><td>132kV</td><td>4600mm</td><td>12200mm</td></tr></table> <p>The peak of towers for 765kV & 400kV shall be 8500mm and for 220kV & 132kV shall be 5200mm.</p> <p>The intermediate gantry height for O/H connection for GT shall be min. 29m+8.50m peak & 25m+ 8.5m Peak for 765kV & 400kV respectively. The gantry width for 765kV, 400kV, 220kV & 132kV AIS shall be min. 30m, 27m, 18m & 12m respectively or as required to meet the specified clearances.</p>				Voltage level	Eqpt./1 st level	Line take off gantry height	765 kV	14000mm	39000mm	400 kV	8000mm	23000mm	220kV	6000mm	17000mm	132kV	4600mm	12200mm
Voltage level	Eqpt./1 st level	Line take off gantry height																	
765 kV	14000mm	39000mm																	
400 kV	8000mm	23000mm																	
220kV	6000mm	17000mm																	
132kV	4600mm	12200mm																	
1.01.17	The switchyard shall be provided with peripheral roads and roads for maintenance/approach for major equipments for maintenance purpose.																		
1.01.18	Voltage drop for sizing of power cables shall not be more than 6%.																		
1.01.19	The illumination level for AIS shall be 20 lux in general and minimum 50lux on equipment boxes. No lighting fixture shall be mounted on gantries, they shall be mounted on LM/ lighting masts only. Specification of lighting is provided elsewhere in the specification.																		
1.01.20	Contractor shall provide panel mounted automatic start / stop type centrifugal self priming pump for sump pit to drain the water in approximately one (1) hour. The contractor shall also provide suitable pedestal/ foundation for this pump. The pump shall be complete with all necessary fittings such as NRV, inlet & outlet pipes of suitable length and dia.																		
1.01.21	All ‘T’ off connections at ‘A’ row associated with transformers shall be provided with a bye pass utilizing two PG clamps for each T off. As far as possible the conductor shall pass without cut/joint unless otherwise necessary for planned shutdown/maintenance.																		
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CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>																					
1.01.22	Area of switchyard shall be provided with broken stone filling which shall consist of two layers. The first layer shall be 75mm thick base course of 20mm of normal size and second layer shall be 75mm thick surface course of 40mm nominal size.																						
1.01.23	Adequate AC & Ventilation of Control room building and Ventilation of GIS Building is to be provided by the contractor. Specification of AC & Ventilation is specified elsewhere.																						
1.02.00	<div>CLEARANCES</div> <div>The minimum clearances for 765kV, 400kV, 220kV & 132kV AIS shall be as given below:</div> <table><thead><tr><th></th><th>765kV</th><th>400kV</th><th>220kV</th><th>132kV</th></tr></thead><tbody><tr><td>Phase to earth clearance</td><td>4900mm (conductor to structure) 6400mm (rod to structure)</td><td>3500mm</td><td>2100mm</td><td>1300mm</td></tr><tr><td>Phase to phase clearance</td><td>7600mm (conductor to conductor) 9400mm (rod to structure)</td><td>4000mm</td><td>2100mm</td><td>1300mm</td></tr><tr><td>Section clearance</td><td>10300mm</td><td>6500mm</td><td>5000mm</td><td>4000mm</td></tr></tbody></table> <div>The Contractor shall supply the structures suitable to meet the above clearances. For 765kV Switchyard, the average limit of 10kV per meter and 500 micro tesla for electric and magnetic field respectively are to be met at a height of 1.8 meter from ground level. The Contractor shall furnish calculations.</div>				765kV	400kV	220kV	132kV	Phase to earth clearance	4900mm (conductor to structure) 6400mm (rod to structure)	3500mm	2100mm	1300mm	Phase to phase clearance	7600mm (conductor to conductor) 9400mm (rod to structure)	4000mm	2100mm	1300mm	Section clearance	10300mm	6500mm	5000mm	4000mm
	765kV	400kV	220kV	132kV																			
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Section clearance	10300mm	6500mm	5000mm	4000mm																			
1.03.00	<div>SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING SUPPLIED</div> <div>The 400kV system shall be designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions.</div> <div>The 800 kV systems is being designed to limit the power frequency over voltage of 1.4 p.u.(base=462kV) and the switching surge over voltage to 1.9 p.u.(base=653) In 765 kV system the initial value of temporary over voltage could be 1.6 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions.</div>																						
1.03.01	<div>SITE SUPERVISION OF EQUIPMENTS</div> <div>The contractor shall ensure that, erection, testing and commissioning of, GIS, Circuit Breaker, Isolator, Instrument Transformer, Surge Arrestor, Substation Automation System & Protective relays is carried out, under the supervision of manufacturer of respective equipment.</div>																						
1.04.00	<div>Insulation Co-Ordination and Selection of Surge Arrestor</div>																						
1.04.01	The contractor shall be fully responsible for complete insulation co-ordination of switchyard. Contractor shall ensure that adequate protective margin is available. If surge arrestors at some more locations other than those indicated in the tender																						
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	drawings are required to be provided, the same shall be deemed to be included in the offer.				
1.05.00	SYSTEM PARAMETERS				
1.05.01	FOR GIS				
	The system parameters shall be as under:				
		<u>765 kV</u>	<u>400kV</u>	<u>220kV</u>	<u>132kV</u>
a)	Highest system voltage	: 800kVrms	420kVrms	245kVrms	145kVrms
b)	Lightning Impulse voltage				
	Phase to earth & between phases	: ±2100kVp	±1425kVp	±1050kVp	±650kVp
c)	Switching impulse voltage	: ±1550kVp	±1050kVp	-----	-----
	Phase to earth				
d)	Power frequency withstand				
	(for 1 min. rms.)				
	Phase to earth & between phases	: 960kVrms	650kVrms	460kVrms	275kVrms
e)	Max. fault level (1 sec.)	: 50 kA	50kA	40kA	31.5kA
f)	PD level for GIS	: Less than 5	Less than 5	Less than 5	Less than 5
		Pico Coulomb	Pico Coulomb	Pico Coulomb	Pico Coulomb
g)	Rated frequency	: 50Hz	50 Hz	50 Hz	50Hz
1.06.00	TYPE TEST REQUIREMENTS				
1.06.01	TYPE TEST REQUIREMENTS FOR EQUIPMENTS OTHER THAN GIS				
a)	All equipments to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out not earlier than ten years prior to the date of techno-commercial bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client.				
b)	However if contractor is not able to submit report of the type test(s) conducted not earlier than ten years prior to the date of techno-commercial bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/ owners representative and submit the reports for approval.				
c)	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.				
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1.06.02	TYPE TEST REQUIREMENTS FOR GIS <p>a) The Contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The Bidder shall indicate the charges for each of these type tests separately in the relevant schedule of BPS and the same shall be considered for the evaluation of bids. The type test charges shall be paid only for the test(s) actually conducted successfully under the contract and upon certification by the Employer's engineer.</p> <p>b) The type tests shall be carried out in the presence of the Employer's representative, for which minimum 30 days notice shall be given by the Contractor. The Contractor shall obtain the Employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set up, instrument to be used, procedure, acceptance norms, recording of various parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.</p> <p>c) In case the Contractor has conducted such specified type test(s) according to the relevant standard and / or specification not earlier than ten years prior to the date of techno-commercial bid opening, he may submit the type test reports to the Employer for waiver of conductance of such type test(s). These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client. The Employer reserves the right to waive conducting of any or all the specified type tests(s) under this contract. In case the type tests are waived, the type test charges shall not be payable to the Contractor.</p>		
1.06.03	Common requirements (For GIS) <p>a) The Employer will have the right of getting any test of reasonable nature carried out on any component or completely assembled equipment at Contractor's premises or at site or in any other place in addition to the aforesaid type and routine tests, to satisfy that the materials/equipment comply with the specification.</p> <p>b) Failure of any equipment to meet the specified requirements of tests carried out at works or at site shall be sufficient cause for rejection of the equipment. Rejection of any equipment will not be held as a valid reason for delay in the completion of the works as per schedule. Contractor shall be responsible for removing all deficiencies, and supplying the equipment that meet the requirement.</p> <p>c) All equipments with their terminal connectors, control cabinets, main protective relays, energy meters etc as well as insulators, insulator strings with hardwares, clamps and connectors, marshalling boxes etc shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections. Charges for the same shall be deemed to be included in the equipment price.</p> <p>The offered GIS equipments shall confirm to the type tests as per IEC 62271-203. The list of the type tests shall be as follows:</p> <p>i) Lightning impulse voltage dry tests.</p> <p>ii) Switching impulse voltage dry tests.</p>		
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	<div><div>iii)</div><div>iv)</div><div>v)</div><div>vi)</div><div>vii)</div><div>viii)</div><div>ix)</div><div>x)</div><div>xi)</div><div>xii)</div><div>xiii)</div><div>xiv)</div><div>xv)</div><div>xvi)</div><div>xvii)</div><div>xviii)</div><div>xix)</div><div>xx)</div></div> <div>Power frequency voltage dry tests. Partial discharge tests. Radio Interference Voltage test Test to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit. Test to prove the ability of the main circuit and earthing circuit to carry the rated peak and the rated short time withstand current. Test to verify the making and breaking capacity of the included switching devices. Test for satisfactory operation of the included switching devices. Test to prove the strength of enclosures. Gas tightness test Electromagnetic capability test (if applicable) Test on partitions Internal arc tests. Mechanical operation tests. Test to prove the satisfactory operation at limit temperature. Verification of degree of protection of auxiliary and control circuits. Test to prove performance under thermal cycling and gas tightness test on gas barrier insulators Capacitive Current switching test Shunt reactor current switching test</div> <div>The components forming parts of the GIS which are covered by other standards shall comply with and shall be type tested according to those standards.</div> <div>d)</div> <div>For surge arrestor and Bus VT following type tests are proposed to be conducted as per relevant IEC.</div> <div><u>Surge Arrestor (As per IEC 60099-4)</u></div> <div>a) Insulation withstand test on housing b) Residual voltage test c) Long duration current impulse withstand test d) Operating duty test e) Partial Discharge Test f) Leakage Test</div> <div><u>BUS VT (As per IEC 60044-2)</u></div> <div>a) Temperature rise test b) Lightning Impulse test c) Switching Impulse d) Determination of errors e) Short circuit withstand capability f) Chopped lighting impulse test</div>		
1.08.00	CORONA AND RIV TESTS AND SEISMIC WITHSTAND TEST: The corona and RIV tests shall confirm to the requirements as per Annexure A to this chapter. The seismic withstand test shall conform to requirements as per Annexure B to this section.		
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Annexure – A

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1.0

General

Unless otherwise stipulated, all equipment together with its associated connectors where applicable shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and measurement of radio interference voltage (RIV).

2.0

Test Levels

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3.0

Test Methods for RIV (765kV, 400kV, 220kV & 132kV):

3.1

RIV tests shall be made according to measuring circuit as per International Special – committee on Radio Interference (CISPR) Publication 16 -1 (1993) Part – I. The measuring circuit shall preferably be tuned to frequency with 10 % of 0.5 MHz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The result shall be in microvolts.

3.2

Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107 – 1964 except otherwise noted herein.

3.3

In measurement of RIV temporary additional external corona shielding may be provided. In measurement of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4

Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% for the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400kV, 220kV & 132kV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5

The metering instruments shall be as per CISPR recommendations or equivalent device so long as it has been used by other testing authorities.

3.6

The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to the voltage read by the noise meter.



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4.0	<p>Test Methods for visible Corona (765kV & 400kV AIS only)</p> <p>The purpose of this test is to determine the corona extinction voltage of the apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130 % of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130 %, the voltage level shall be raised till inception of corona or rated voltage whichever is lower. The voltage will then be decreased slowly until all visible corona disappears. The test procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which the visible corona (negative or positive polarity) disappears.</p> <p style="text-align: right;">Annexure – B</p> <p>SEISMIC WITHSTAND TEST (for 765 kV & 400kV AIS only)</p> <p>a.) The seismic withstand test on the complete equipment (except BPI) shall be carried out along with supporting structure.</p> <p>b.) The bidder shall arrange to transport the structure from his contractor's premises / owner's sites for purpose of seismic withstand test only.</p> <p>c.) The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the terminal pad of the equipment and at any other point as agreed by the owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the purchaser.</p>		
2.00.00	REQUIREMENTS FOR GAS INSULATED SWITCHYARD		
2.01.00	GENERAL		
2.01.01	The GIS shall comply to IEC – 62271-203. The general requirements and special requirements for Gas Insulated Switchgear (GIS) are given in this chapter. GIS shall also meet other requirements specified under switchyard for various equipments as applicable. Materials and components not specifically stated in this specification but are necessary for the satisfactory operation of the equipment shall be deemed to be included unless specifically excluded and shall be supplied at no extra cost.		
2.01.02	The GIS shall be modular in structure and shall be housed indoor. The modules shall be single phase encapsulated for 765kV & 400kV & single/ three phase encapsulated for 220kV & 132kV and provided with hooks for handling by EOT cranes to be provided in the building. The modular design shall be capable of extension on either side without any major dismantling.		
2.01.03	The GIS equipments for 765kV, 400kV, 220kV & 132kV shall be housed in separate GIS building of overall height and width determined by the layout arrangement.		
2.01.04	The bus bars shall be rated for the duty specified and current rating shall be derived		
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<p>2.02.00</p> <p>2.02.01</p> <p>2.02.02</p> <p>2.02.03</p> <p>2.02.04</p> <p>2.02.05</p> <p>2.02.06</p> <p>2.02.07</p> <p>2.02.08</p> <p>2.02.09</p> <p>2.02.10</p> <p>a)</p> <p>2.03.00</p> <p>2.03.01</p>	<p>considering maximum possibilities.</p> <p>TECHNICAL REQUIREMENTS:</p> <p>The requirements for all switchyard equipments are given in subsequent sections.</p> <p>The VT's for GIS shall be installed within the GIS enclosure and shall be SF6 gas insulated or cast resin type. The secondary terminals shall be brought out in a dust proof enclosure suitably.</p> <p>The Surge arrestors for main buses shall be of GIS type only.</p> <p>The earthing of the GIS shall be carried out considering the safety requirements as per relevant standards. All parts to which access is required for maintenance work shall have provision for earthing. In addition after opening of enclosure it shall be possible to have continuity of earth for the duration of work. The continuity of earthing shall be ensured considering electrical and thermal stresses caused by current they may have to carry.</p> <p>Each section & phase of the GIS enclosure shall be monitored for leakage of SF6 gas and suitable indication shall be provided in the control room.</p> <p>All components of the same rating and construction shall be interchangeable.</p> <p>Each breaker module of the GIS shall have a local control cabinet suitably located and shall be ground mounted meeting the requirements specified elsewhere for cabinets. Suitable interlocking arrangements shall be provided for the entire GIS.</p> <p>All the SF6 gas insulated circuit breakers, disconnectors, grounding switches and bus bars shall be of single phase isolated type for 765 kV & 400 kV and three/ single phase isolated type for 220kV & 132kV .</p> <p>Protective Finish -Preferable</p> <p>All the exterior surfaces shall be cleaned and painted before leaving the factory with one coat of approved primer and two coats of water resistant approved paint on the equipment. The under-side of all painted surfaces bearing upon the concrete foundation shall be given two coats of approved primer. Extra paint for retouching at site shall be made available by the Contractor.</p> <p>Fire Retardancy</p> <p>All components shall be fire retardant and shall be tested in accordance with IEC 695.</p> <p>DESIGN AND SAFETY REQUIREMENT</p> <p>The GIS assembly shall be as per switching arrangement indicated under single line diagram and consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled SF6 gas and separated gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that</p>		
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	<p>maintenance on one feeder may be performed without de-energizing the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions. The compartments of GIS assemblies shall be supplied filled with nitrogen/ air or dry SF₆ gas at a positive pressure and hermetically sealed to protect the dielectric system during transportation.</p> <p>2.03.02 The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear.</p> <p>2.03.03 The switchgear, which shall be of modular design. The conductors and the live parts shall be mounted on insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF₆ breakdown under arcing conditions.</p> <p>2.03.04 Gas barrier insulators and support insulators shall have the same basis of design. The support insulators shall have holes on both sides for proper flow of gas.</p> <p>2.03.05 Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. They shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand 1.5 times full rated pressure on one side while vacuum is exerted on the other side. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Due to safety requirement for working on the pressurized equipment, whenever the pressure of the adjacent gas compartment is reduced, it should be ensured by the contractor that adjacent compartment would remain in service with reduced pressure. The gas tight barriers shall be clearly marked on the outside of the enclosures.</p> <p>2.03.06 The material and thickness of the enclosures shall be such as to withstand an internal flash over without burn through for a period of 300ms at rated short time withstand current. The material shall be such that it has no effect of environment as well as from the by-products of SF₆ breakdown under arcing condition.</p> <p>2.03.07 Sufficient inspection windows/access openings shall be provided at the switchgear to ensure that each switchgear component can be inspected / monitored during installation and future maintenance. Each section shall have plug-in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the equipment.</p> <p>2.03.08 The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminum/ copper tubes of cross sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to</p>		
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	temperature variation without imposing any mechanical stress on supporting insulators.		
2.03.09	Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC -62271-203 .		
2.03.10	The maximum SF6 gas leakage shall not exceed half percent (0.5%) per year for the whole equipments and for any individual gas compartment separately.		
2.03.11	Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. The filters shall be capable of absorbing any water vapour which may penetrate into the enclosures as well as the by-products of SF6 during interruption. Each gas compartment shall be fitted with separate non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.		
2.03.12	The switchgear line-up when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated & fault conditions shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.		
2.03.13	Void.		
2.03.14	The thermal rating of all current carrying parts shall be minimum for one sec. for the rated symmetrical short-circuits current.		
2.03.15	The Switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high-voltage equipment installed inside gas-insulated metallic and earthed enclosures, suitably sub-divided into individual arc and gas-proof compartments at least for: a) Bus bars b) Intermediate compartment c) Circuit breakers d) Bus / Line disconnections e) Gas insulated bus duct sections f) Voltage Transformers g) Surge Arrestors The bus enclosure should be sectionalized in a manner that maintenance work can be carried out by isolating and evacuating the small effected section and not the entire bus.		
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	<p>The design of the one and half breaker scheme GIS shall be such that in case one circuit breaker module is removed for maintenance, there is no disruption in the power flow in any of the two circuits in a diameter.</p> <p>The design of double bus scheme shall be such that the common point of the two bus bars along with the earth switch shall be designed and housed in a separate compartments so as to avoid complete shutdown of the system in case of maintenance required in any bus disconnector. Further maintenance on one bus disconnector should be possible when the feeder is live through other disconnector.</p>			
2.03.16	The arrangement of the individual switchgear bays shall be such so as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.			
2.03.17	It is required that the three phases of each switchgear bay be arranged side by side. The arrangement of the equipment offered must provide adequate access for operation, testing and maintenance.			
2.03.18	The arrangement of gas section or compartments shall be such as to facilitate extension of any make on either end without any drilling, cutting or welding on existing equipments. The GIS shall be designed such that a future requirement as per single line diagram can be extended with-out any necessity to move or dislocate the existing switchgear bays. It shall be kept in view that very little shutdown time is needed for adding future requirement.			
2.03.19	All the elements shall be accessible without removing support structures for routine inspections and possible repairs. The removal of individual enclosure part or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays.			
	It should be impossible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force.			
2.03.20	All interlocks that prevent potentially dangerous mal operations shall be constructed such that they can not be operated easily, i.e. the operator must use tools or brute force to over-ride them.			
2.03.21	The actual position of circuit breakers, disconnectors and grounding switches must be positively displayed by mechanical indicators visible from the operating position.			
2.03.22	In general the contours of energized metal parts of the GIS and any other accessory shall be such, so as to eliminate areas or points of high electrostatic flux concentrations. The surfaces shall be smooth with no projection or irregularities which may cause visible discharges. There shall be no radio interference from the energized switchgear at rated voltage.			
2.03.24	The fabricated metal enclosures shall be of Aluminum alloy and have high resistance to corrosion, low electrical losses and negligible magnetic losses. All jointed surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall conform to metric system.			
2.03.25	The breaker enclosure shall have provision for easy withdrawal of the interrupter			
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	assemblies/complete CB pole.			
2.03.26	The enclosures of the same phase shall be electrically interconnected and at proper points they shall be connected to the other phases thus entailing a return current almost equal to the current circulating in the conductors.			
2.03.27	The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electrodynamic stresses even under short circuit conditions.			
2.03.28	The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.			
2.03.29	The switchgear shall have provision for connection with ground mat risers. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment. The connection between the grounding pads of switchgear and ground mat risers shall be provided by the contractor. The contractor shall furnish the design details & drawings for ground mat for GIS.			
2.03.30	The ladders and walkways shall be provided wherever necessary for access to the equipment.			
2.03.31	Wherever required, the heaters shall be provided for the equipment in order to ensure the proper functioning of the switchgear at specified ambient temperatures. The heaters shall be rated for 240V AC supply and shall be complete with thermostat, control switches and fuses, connected as balanced 3-phase, 4-wire load.			
2.03.32	Arrangement shall be provided to visually observe the contact position of disconnecting switches and earth switches.			
2.03.33	The enclosure & support structure shall be designed that a mechanic 1780mm in height and 80 Kg in weight shall be able to climb on the equipment for maintenance.			
2.03.34	The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.			
2.03.35	Alarm circuit shall not respond to faults for momentary conditions. The following indications in addition to those required elsewhere in the specifications shall be provided in the alarm & indication circuits in Bay Module Control Cabinets:			
I)	Gas Insulating System			
a)	Loss of gas density			
b)	Loss of heater power (if required)			
c)	Any other alarm necessary to indicate deterioration of the gas insulating system			
II)	Operating System			
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<p>a) Low operating pressure.</p> <p>b) Loss of Heater Power.</p> <p>c) Loss of operating power.</p> <p>d) Loss of control</p> <p>e) Pole-disordance</p>	<p>In addition, all the above alarms shall also be hooked up to the Substation Automation system.</p>
2.03.36	Each gas compartment barrier shall be easily identifiable from the outside of the switchgear.
2.03.37	Maximum weight of gas in gas tight section of GIS duct shall not exceed 400 kg (for 765kV & 400kV) and 250 kg (for 220kV & 132kV)
2.03.38	The equipment shall be suitable for operation under the ambient conditions prevailing at project site. The prevailing conditions shall be taken into account by the Contractor in the design of the equipment.
2.04.00	<p>MANDATORY MAINTENANCE EQUIPMENTS</p> <p>The maintenance equipment necessary for the operation and maintenance of GIS shall be supplied. The requirement of such equipments is enclosed at Annexure-C of this section.</p>
2.05.00	<p>MANDATORY MONITORING EQUIPMENTS</p> <p>The monitoring equipment necessary for the operation and maintenance of GIS shall be supplied. A list of such equipments is enclosed at Annexure-D of this section.</p>
2.06.00	<p>BELLOWS OR COMPENSATING UNITS</p> <p>Adequate provision shall be made to allow for the thermal expansion of the conductors and of differential thermal expansion between the conductors and the enclosures. The metallic bellows (preferably of stainless steel) of following types or other suitable arrangement shall be provided wherever necessary:</p> <ul style="list-style-type: none"> i) To enable sections of the switchgear to be removed and reinserted without interfering with adjacent parts. ii) To accommodate changes in length of bus bars due to temperature variations. iii) To accommodate large linear expansions and angle tolerances. iv) For taking up manufacturing, site assembly & foundation tolerances. v) for absorbing vibrations caused by the transformers when connected to SF6 switchgear by oil / SF6 bushings.
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2.07.00	INDICATION AND VERIFICATION OF SWITCH POSITIONS Indicators shall be provided on all circuit breakers, Disconnectors and earth switches, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkage and shall be mounted in a position where they are clearly visible through glass windows.		
2.08.00	PRESSURE RELIEF Pressure relief devices shall be provided in the gas sections to protect the main gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably) in downward direction). Pressure relief devices shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction. If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided. Contractor shall submit to the owner the detailed criteria design regarding location of pressure relief devices/rupture diaphragms.		
2.09.00	PRESSURE VESSEL REQUIREMENTS The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel code (ASME/CENELEC code for pressure Vessel.) The bursting strength of Aluminium casting has to be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure. Each enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute.		
2.10.00	BUSBARS		
2.10.01	The conductors of the bus bars shall be fabricated from aluminum/copper tubular sections of cross- sectional area suitable to meet the current rating requirements. . The tubular bus section shall be housed in corrosion resistant aluminum enclosures, filled with pressurized SF6 gas. The conductors shall be supported from the enclosures by insulators shaped to ensure uniform electrical field distribution and zero corona at rated voltage. Adequate provisions shall be made for absorption of the thermal expansions between the conductors and the enclosures. The metal bellow type compensators for adjusting tension shall be provided where ever required. The enclosures shall be designed to eliminate as much as possible all external effects of the flux created by normal and fault currents. The power losses in the system shall be kept to a minimum. The induced voltages on the enclosures shall not be allowed to exceed reasonable limits of safety for operating personnel.		
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2.10.02	The bus end connections shall be made with multi-contact connectors to allow for axial thermal expansion of the bus. The enclosure connections shall be flanged and shall be fitted with gaskets or O-ring seals to provide an effective gastight joint between sections.		
2.10.03	Main bus bars shall be designed to have future extension bay if any as indicated in the single line diagram. The bus conductor end connectors and enclosure flanges shall be designed accordingly.		
2.10.04	All necessary indoor and outdoor galvanised steel supporting structures for the proper erection, leveling and alignment of the bus bars shall be provided by the Contractor.		
2.10.05	The SF6 GIS bus-bars shall have continuous current rating as shown in the single line diagram or as required for the system.		
2.10.06	The system employed shall be of the electrically continuous enclosure type, allowing free circulation of induced currents in the enclosures. The enclosures shall be cylindrical in shape and designed for maximum shielding to minimize electromagnetic forces caused by short circuit currents.		
2.10.07	Wherever necessary, to absorb expansion / contraction, relative movement between the various items of equipment and the earthquake forces, bellows or other means shall be provided. The contractor must submit details of the means deployed along with the offer.		
2.11.00	BAY MODULE CONTROL CABINETS		
2.11.01	Each switchgear bay module shall be suitable for local control and remote control. The contractor shall supply the main control cabinet of the floor standing type along with GIS equipments. The cabinet shall have double, full height, hinged, gasketed, lockable doors. One door shall have a safety glass window through which the various switchgear controls can be viewed without opening the doors.		
2.11.02	The cabinet will be utilized for the switchgear bay local control module and as the terminating center for all power supply, control annunciation and supervisory wiring interfacing with Employer's systems.		
2.11.03	The following equipments shall be mounted on the cabinet door: <div><div>- Remote/local control transfer switch for the circuit breakers and disconnector switches.</div><div>- Normal operation/maintenance control transfer switch for disconnector of remote electrical controls.</div><div>- Mimic diagram of the switchgear bay complete with semaphore indicators for the switchgear component position indication and local control switches for open / close or close-trip control of the circuit breaker, isolators and grounding switches.</div></div>		
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2.11.04	The following equipments shall be mounted internally in the cabinet: <ul style="list-style-type: none">- All bay switchgear interlocking wiring and auxiliary relays.- AC and DC power supply circuit breakers.- All necessary incoming and outgoing terminal blocks.- Space heaters- All instruments and devices required for supervision & control of GIS			
2.11.05	The annunciator system shall have sufficient modules and illuminated windows for providing annunciation for low / high gas pressure / density, alarms & trips for circuit breaker operating mechanism and all other abnormal conditions.			
2.11.06	Each annunciator panel shall be complete with an audible warning horn, acknowledge/reset for horn silence and lamp test push buttons. Apart from annunciator system in LCC, alarm contacts for remote alarm indication shall have to be wired separately in LCC terminal block.			
2.11.07	The control cabinets shall be suitable for bottom entry of cables.			
2.12.00	SUPPORTING STRUCTURES			
2.12.01	The Contractor shall design, fabricate and supply the equipment supporting framework including all rails, transverse & longitudinal beams and supporting members with all necessary hardware & embedded parts. General structural designs and structural details shall be subject to the approval of the Employer.			
2.12.02	The floor of the switchgear building will be designed to support all the loads imposed by the equipment supporting framework. The Contractor shall make provision in his designs to minimize transfer of forces resulting from thermal expansion or switchgear operation to the walls & floors of the switchgear building. To facilitate the design of floor of switchgear, the Contractor shall supply the details of static and dynamic loads to be supported by the slab along with the offer.			
2.12.03	Non-corrosive metal or cadmium plated steel shall be used for bolts and nuts throughout the work when either or both are subjected to frequent adjustment or removal.			
2.12.04	All steel structure members shall be hot dip galvanised.			
2.12.05	All supporting structures shall be designed in such a way so as to allow dismantling for the addition of further switchgear components or maintenance of existing equipment without requiring temporary supports.			
2.12.06	The supporting arrangements for the GIS duct outside the building shall have adequate provision for thermal expansion/seismic forces etc.			
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2.13.00	MONITORING			
2.13.01	The gas density in each gas compartment shall be monitored by electrically isolated & independently adjustable temperature compensated density switches. The factory set density switches shall also be acceptable. The relative merits, however for such switches in place of adjustable density switches shall be indicated in the offer. Two level density switches shall be provided for each GIS bus compartment to initiate remote devices of level-I alarm and level-II tripping. The setting of level-I alarm and level – II tripping shall be such that the dielectric strengths of SF6 gas are maintained. The necessary indication shall be provided at the circuit breaker control cabinet identifying the gas compartment from which a level-I alarm is initiated. Two level density switches shall be provided for each circuit breaker compartment to initiate the following:			
i)	Level-I- Remote alarm and prevent closing of the breaker in case it is open.			
ii)	Level-II- Initiation of Zone trip, Contact shall be in accordance with the requirement.			
2.13.02	Gas pressure monitoring devices shall be fitted with test valves such that field testing of the monitoring device can be performed without draining the main gas system.			
2.13.03	Each gas section shall be fitted with a suitable valve for routine gas sampling.			
2.13.04	The Contractor shall satisfy the Employer regarding accuracy limits of gas monitoring devices.			
2.13.05	The equipment shall have provision to monitor the following parameters periodically to check anomalies and/or wear & tear of equipment.			
i)	Operation of mechanical components: The parameters to be monitored are: - Fluid pressure(oil) or hydraulic mechanism power reserve - The displacement speed of the moving parts - The travel of moving parts - Friction of moving parts			
ii)	Wear of circuit breakers interrupting chamber: The parameters to be monitored are: - Determination of contact closing position - Accumulated effect of interrupted currents			
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iii)	<div>- Decomposition products content in SF6 Gas</div> <div>Insulation failure:</div> <div>The parameters to be monitored are:</div> <div><div>- SF6 gas density monitoring of all the compartments</div><div>- High frequency current detection for partial discharge detection</div><div>- Sonic detection</div></div>			
	iv)	Safety bursting disc for each SF6 gas compartment.		
2.14.00	HIGH VOLTAGE TRANSIENTS			
	High voltage transients from switching operations and internal faults are coupled to the external enclosure of the GIS. Since the effects of these transients on people are not known, the operating personnel are required to avoid contact with the enclosure during switching operations. The contractor is therefore required to establish that the reduced transient levels are within acceptable level.			
2.15.00	BURN THROUGH PREVENTION			
	The Contractor shall furnish the details regarding the design features of their equipment which are intended to prevent burn through when an internal arc occurs.			
2.16.00	HEATERS			
	All the heaters shall be suitable for connection to a 240V AC, single phase, 50 Hz supply. The heater in the mechanism housing shall be connected inside the housing to this supply and shall be thermostatically controlled. The leads to the tank heaters shall be enclosed in a conduit.			
	All the thermostats and the temperature indicating devices shall be calibrated in metric units.			
2.17.00(A)	SERVICE LIFE			
	SF6 circuit breakers, disconnecting switches and grounding switches will be subjected to frequent and occasionally repetitive, no load / full load operations and switching off short circuit currents , capacitive and inductive currents within their ratings. The Contractor shall propose the recommended period for scheduled maintenance.			
2.17.00 (B)	SEISMIC DESIGN CRITERIA:			
a)	The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act on concurrently. Seismic Qualification requirements shall be as per IEC 62271-207 for the design of equipment. The equipment along			
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	<p>with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation, but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. The copies of type test reports for similar rated equipment, if tested earlier, should be furnished. If the equipment has not been type tested earlier, Test Report/Analysis Report should be furnished.</p> <p>b) To prevent the movement of GIS sub-assemblies i.e. various bay modules during the earthquake, suitable devices shall be provided for fixing the sub-assemblies to the foundation. The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub-assemblies to the foundation shall be designed to withstand the seismic events. It will also be ensured that the special devices as well as bolts shall not be over stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to the employer's approval.</p>		
2.18.00	INSPECTION AND TESTING		
2.18.01	All the equipment, apparatus, materials and supplies provided by the contractor under the contract shall be subjected to tests in the shop and at the field in the presence of employer for conformity with the requirements of the specifications. be as specified for the particular item or shall be in conformity with the applicable recognized standards for making such test. The details of the test procedures and test equipment to be used should be intimated to the Employer well in advance i.e. no less than 30 days before these tests are conducted. Unless otherwise specified, the contractor shall perform all shop and field tests.		
2.18.02	The Contractor shall submit a detailed quality assurance plan with 30 days after the commencement date intimating the testing program to the Employer for testing may proceed with minimum delay. The performances tests shall start, proceed, stop and be resumed in accordance with the approved schedule.		
2.18.03	The Contractor shall, at its own expense, promptly make good all defects evident by testing or made apparent in any other ways. After defects in the equipment have been rectified, the equipment is proved to be in satisfactory operation.		
2.18.04	Within 30 days of completion of each and every specified test, including commissioning tests, the Contractor shall submit six signed copies of the test reports to the Employer.		
2.18.05	The test reports shall indicate the tests performed, the result obtained, instruments used, names of personnel carrying out the tests and provisions for signature of witnesses. They shall also show the number and date. The format of these reports shall be submitted along with testing procedure for the employer's approval well in advance.		
2.18.06	<p>The test report shall include, but not necessarily be limited to the following:</p> <ul style="list-style-type: none">- A description of the test equipment with diagram showing arrangement of the test instruments and devices.- Sample computations, wherever necessary or desirable to show the test		
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	<p>values employed in the equations.</p> <ul style="list-style-type: none">- Curves showing relation of tested quantities- Data in tabulated form <p>The comparison of the test results with the guaranteed requirements of the specification and explanation of deviations, if any.</p>			
2.19.00	Shop test			
2.19.01	All major part of equipment, is essentially those necessitating subdivision of parts are transport and subsequent and reassembly at site, shall be matched, assembled in the factory and carefully marked before dismantling. The dowel holes shall be provided with dowels to assist reassembly. The accuracy of fitting has to be assured at site at all stages of assembly.			
2.19.02	Each transport section of switchgear shall be shop tested.			
2.19.03	<p>Switchgear components forming part of GIS namely circuit breakers, disconnectors, grounding switches, current transformers, Voltage transformers, surge arrestors & SF6 interface bushing, the routine tests of which have been covered under other relevant IEC standards and which do not form the part of tests specified below shall have these tests performed before being assembled into the switchgear. However, for electronic modules, equipment and individual components burn-in tests, temperature & voltage stress tests shall also be performed. Routine tests shall be conducted by automatic processes, wherever practicable particularly during testing of wiring. An example of the other tests referred to above would be as follows:</p> <ul style="list-style-type: none">a) Verification of terminal markings and accuracy & composite error tests for current and potential transformers.b) Routine and standard acceptance tests for surge arrestors specified in IEC60099-4 relevant to metal oxide type arrestors without gaps.c) Routine tests (on transport section):<ul style="list-style-type: none">i) Dry Power frequency voltage withstand tests on the main circuit.ii) Dielectric tests on auxiliary and control circuit.iii) Tests to verify the resistance of the main circuitiv) Partial discharge testsv) Pressure test on enclosuresvi) Gas tightness test.vii) Mechanical operation tests.			
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	<div><div><div>viii) Tests of auxiliary, electrical and hydraulic devices.</div><div>ix) Check of wiring.</div><div>x) Power frequency voltage dry tests</div><div>xi) Voltage tests on auxiliary and control circuits</div><div>xii) Fluid leakage tests (where applicable)</div></div><div>The applicable standards for the above tests shall be IEC 62271-203, IEC 62271-100 and IEC 62271-1.</div><div>In addition, corrosion protection tests at random on all equipment shall be performed.</div></div>			
2.20.00	Type Tests			
	For Type Test requirement, Please refer clause No.1.06.02 & 1.06.03.			
2.21.00	Performance Tests			
	<p>Performance tests will be required to prove that equipment meets the requirements of the specifications and the guarantees. All the tests shall be conducted by the contractor subject to Employer's approval. The contractor shall supply all labour, consumables, materials, equipment, meters, gauges etc. necessary for the performance of all the tests and recording the results of the tests. The contractor shall assume full responsibility for the operation and safety of the equipment during all tests. The reports of all the tests shall be prepared by the contractor and incorporated in the final test report. The performance tests shall comprise of:</p> <div><div>a)</div><div>Field stage tests, to be carried out during erection, to demonstrate that the equipment or any component or subassembly has been properly erected and functions correctly.</div></div> <div><div>b)</div><div>Commissioning tests, precedent to the acceptance of work, in respect of the equipment or any section of the equipment, to demonstrate proper operation.</div></div>			
2.22.00	Field Stage Tests:			
	<p>From time to time at various stages of erection, tests of sub-assemblies of the equipment shall be carried out as instructed by the Employer. The contractor shall make records of all measurements and shall make corrections or adjustments as required. A record of all stage tests shall be embodied in a report. These tests shall include, but not be limited to the following:</p> <div><div>(a)</div><div>Continuous testing of the properties of SF6 gas through the entire filling period.</div></div> <div><div>(b)</div><div>Test to check the continuity of wiring and correct operation of electrical</div></div>			
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2.23.00	<p>systems.</p> <p>(c) Testing of all current carrying & ground connections to all conductors and terminal pads, to determine that the surfaces & all the bolted connections are tightly secured with lock washers; testing of all the flexible connections to ensure that sufficient slack is available for expansion.</p> <p>(d) Individual inspection of pressure relief devices, pressure gauges, moisture detectors and all other auxiliary devices to examine their condition.</p> <p>(e) Checking of cabling between apparatus by the contractor, prior to acceptance tests. Written evidence shall be produced on these tests. Random checks shall be made in the presence of the Engineer.</p> <p>(f) Measurement of the insulation resistance of the various measuring and control circuits, including cables, instruments and apparatus wherever practical and feasible.</p> <p>(g) Operation checks of operating mechanism, all control, signaling, measuring, metering, recording and interlocking equipment to confirm complete conformity with designed data.</p> <p>Prior to commencement of these tests, the contractor shall submit a detailed programme to Employer's for approval. Detailed records, including all the details of tests performed and the results obtained shall be prepared by the contractor and furnished to the Employer.</p>		
	<p>Commissioning Tests</p> <p>On completion of the erection and installation, following commissioning tests shall be performed as per IEC 62271-203, CIGRE working Group 23.03, 1975-Electra No.42, 7-29:</p> <p>(a) One minute power frequency withstand tests for the main circuits. As per IEC 62271-203 high voltage tests at site with lightning impulse and switching impulse voltages are also acceptable as alternative. The Contractor may carry out either of the above tests but relative merits of particular type of test over the other tests to be carried out by the contractor should be indicated in the offer.</p> <p>(b) Partial discharge measurement tests.</p> <p>(c) Voltage tests for the main circuits</p> <p>(d) Voltage tests for the auxiliary and control circuits.</p> <p>(e) Tests to verify the resistance of the main circuits.</p> <p>(f) Operation tests for various components.</p> <p>(g) Gas leakage tests.</p>		
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	(h) Calibration/checking of SF6 gas pressure/density switches.					
	Measurement of moisture.					
	After erection, a test shall be made to prove the absence of the dangerous voltages in the enclosure and other metal parts such as pipes and framework. If the tests prove the existence of any fault or faults in the equipment, or any failure to meet the requirements of the specifications the Employer may direct Contractor to rectify the defects or repair, reconstruct or replace faulty work and Contractor shall without delay, carry out the instructions of the Employer in this respect.					
	Except as otherwise provided hereunder, responsibility for apparatus & test equipment and the control thereof shall be exercised by contractor subject to the over riding control of the Employer.					
	Commissioning tests shall be as per the IEC standard and shall not be restricted to the tests stated above. The Contractor shall also recommend any additional commissioning tests.					
2.24.00	Final Acceptance Tests					
	After commissioning tests have been satisfactorily completed, the contractor shall carry out tests as per relevant standards.					
2.25.00	Test Reports					
	The contractor shall record all the relevant facts and the quantities on the basis of which a final test report shall be prepared. Such reports will be prepared in a form approved by the Employer and reproduced at the expense of the contractor in six copies for submission to the Employer.					
2.26.00	TRAINING: GIS manufacturer Shall Provide Training to the Employer's Personnel as per the Details Given Below:					
	SI No.	Description of Training	Training Duration (Days)	Place of Training	Number of Trainees from Employer	Boarding & Lodging
	1	GIS				
	a)	GIS equipments including system description, Basic Design and engineering, Quality Assurance concepts, Erection and operational aspects for the offered equipments.	5 days	Manufacturers works	8	To be provided by Bidder
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SI No.	Description of Training	Training Duration (Days)	Place of Training	Number of Trainees from Employer	Boarding & Lodging
b)	Operation, Maintenance, Site Testing and Trouble shooting for GIS.	5 days	Site	6	-

Annexure-C

SPECIFICATION OF MANDATORY MAINTENANCE EQUIPMENT

1.0

SF6 Gas Handling Plants:-

a) SF6 gas filling and evacuating equipment (Portable)

The capacity of this plant shall be such that it shall not take appreciable time for filling or evacuating of largest compartment. The required vacuum for complete evacuation shall be attained with the help of this plant.


b) SF6 gas filtering, drying, storage and recycling plant-

- The plant shall be complete with accessories and fittings so that SF6 gas from the breaker can be directly filled in the plant storage reservoir.
- In case purging of the equipment before filling with SF6 gas is desirable, then the required equipment for dry gases etc. shall be furnished as a part of the plant.
- For heavy items within the plant, the lifting hooks shall be provided for lifting and moving with the overhead cranes.
- The capacity of the plant shall be such as to handle and store the maximum quantity of gas that could be removed from atleast one phase of complete one bay.


Note:

- i) These SF6 gas handling plants shall be complete with all the necessary pipes, couplings flexible tubes and valves for coupling to the equipment.
- ii) The design and construction of the plant, valves, couplings, and connections shall be such that leakage of SF6 gas shall be minimum. Similarly valves, couplings and pipe work shall be so arranged that accidental loss of gas to




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2.0	the atmosphere shall be minimum.			
	SF6 gas analyzer The SF6 gas analyser should be portable type and instrument should have following features: <ul style="list-style-type: none">a. Sensitivity of the equipment shall not be affected by any atmospheric conditions like dust, humidity, heat, wind etc.b. Equipment should be equipped with pumped back facilities so that no SF6 gas is wasted.c. Equipment shall be supplied with suitable regulator which can be used to connect SF6 cylinder if required.d. Following acidic/impurities products should be detected as per IEC 60480 and IEC 60376<ul style="list-style-type: none">i) SF6 purity – Range: 0-100 %ii) Dew point - Range: -60 to +20 deg Ciii) SO2 - Range: 0-150 ppmiv) CF4 – Range: 0-60% volv) HF - Range: 0-25 µl/le. Instrument should work on AC source as well as on rechargeable batteryf. Input pressure: upto 10 barg. It should be housed in a robust IP67 case with wheels			
3.0	SF6 Gas leak detector - The SF6 gas leak detector shall meet the following requirements: <ul style="list-style-type: none">a) The detector shall be free from induced voltage effects.b) The sensing probe shall be such that it can reach all the points on the GIS where leakage is to be sensed.c) The accuracy of the equipment shall be at least 10 ppm.			
4.0	Operational analyser with DCRM kit- The operational analyser shall meet the following requirements: <ul style="list-style-type: none">a) Operational analyser shall be one complete system, which once installed should record all the parameters, as laid down in subsequent clauses.b) It shall have facility to record the breaker contact movement during opening, closing, auto reclosing and make-break operation, the speed of contacts at various stages of operation, travel of contacts, opening time, closing time and make break time ,etc.c) The analyser shall have provisions for recording atleast 12 different functions of the circuit breaker. All necessary transducers (i.e. three nos. for complete 3 phase speed and travel record of breaker), cables, pickups, attachments			
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	<p>required for the breaker shall be supplied with the analyser. The cables supplied shall be sufficient enough for recordings at site on a completely assembled and erected breaker.</p> <p>d) The analyser shall be suitable for operation outdoor and shall be suitably shielded against induced charges.</p> <p>e) The output of the analyser shall be on a plain paper or any paper having infinite shelf life and the output thus obtained shall have a long life and shall not require any special storage facility. Photographic paper is not acceptable.</p> <p>f) All the necessary catalogues, write up for operation and maintenance of the analyser shall be furnished alongwith each analyser and peripheral system.</p> <p>g) Demonstration at manufacturer's premises for functional/operational check and compatibility with breaker.</p> <p>h) The necessary equipments for monitoring various parameters of circuit breaker termed as signature analysing shall be supplied along with all softwares, laptop computer, devices etc. with the breaker. The same shall be demonstrated at site on a fully assembled breaker.</p>			
5.0	<p>All above maintenance equipments shall be demonstrated at site during handover.</p> <p style="text-align: right;">Annexure-D</p>			
	<p>MANDATORY MONITORING EQUIPMENTS</p>			
1.0	<p>Dew Point Meter</p> <p>i) The meter shall be capable of measuring the dew point of SF6 Gas of the Circuit Breaker/GIS equipment It should be portable and adequately protected for outdoor use. The meter shall be provided with dew point hygrometer with digital indication to display the dew point temperature in degree C. or PPM. It should be capable of measuring the corresponding pressure at which dew point is being measured.</p> <p>The measurement and use of the instrument must be simple, direct without the use of any other material/chemical like dry ice/acetone etc. It should be battery operated with rechargeable batteries.</p> <p>ii) The equipments should have the following parameters</p> <p>a. Measuring range: Up to -100 degree C Dew Point</p> <p>b. Accuracy: + 2 degree C.</p> <p>c. Display: 4 digit LCD, inch. High</p>			
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2.0	PORTABLE PD MONITORING SYSTEM FOR GAS INSULATED SWITCHGEAR			
	<div><div>i)</div><div>The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs.</div></div> <div><div>ii)</div><div>It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 10 KHz – 500 KHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principal of operation and the method of measurement shall be non-intrusive. The instrument is able to detect partial discharges in cable joints, terminations, CTs and VTs etc., with the hot sticks.</div></div> <div><div>iii)</div><div>Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc.</div></div> <div><div>iv)</div><div><div>The equipments should have the following parameters:</div><div><div>a)</div><div>Measurement shall be possible in noisy environment.</div></div><div><div>b)</div><div>Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD.</div></div><div><div>c)</div><div>Environment should have necessary synchronizing circuits to obtain PD correlation with power cycle and power frequency.</div></div><div><div>d)</div><div>The equipment shall be battery operated with built-in battery charger. It shall also be suitable for 230V AVC/50 Hz input.</div></div><div><div>e)</div><div>Measurement shall be possible in the charged switchyard in the presence of EMI/EMC. Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be supplied along with the offer.</div></div><div><div>f)</div><div>Instrument shall be supplied with standard accessories i.e. connecting cables (duly screened) to sensors, Lap-top PC, diagnostic software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50 Hz supply connecting cables (duly screened) to view in storage. Contractor shall provide adequate number of sensors in the offered GIS for detection of Partial discharge, the number and location of these sensor shall be subject to approval of the employer.</div></div><div><div>g)</div><div><div>The function of software shall cover the following :</div><div><div>-</div><div>Data recording, storage and retrival in computer</div></div></div></div></div></div>			
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	<ul style="list-style-type: none"> - Data base analysis - Template analysis for easy location of fault inside the GIS - Evaluation of PD measurement i.e., Amplitude, Phase Synchronisation etc. - Evaluation of bouncing/loose particles with flight time and estimation on size of particle. - Report generation <p>h) To prove the suitability of working in charged switchyard condition, practical demonstration shall be conducted before acceptance.</p> <p>i) Supplier shall have “Adequate after sales service” facility in India.</p> <p>j) Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS.</p> <p>k) Instrument shall be robust and conform to relevant standard.</p> <p>l) Adequate number of UHF sensors shall be provided in the offered GIS for detection of Partial discharge as per IEC 60270 through Partial Discharge (PD) monitoring system and the number and location of these sensors shall be subject to approval of the employer. Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.</p>			
3.00.00	CIRCUIT BREAKER			
3.01.00	GENERAL			
	<p>Circuit Breakers shall be metal enclosed SF6 gas insulated, single phase encapsulated for GIS and outdoor type Sf6 gas insulated for AIS, both comprising three identical single pole units, complete in all respects with all fittings and wiring. The circuit breakers and accessories shall conform to relevant standard.</p> <p>The controlled switching device for circuit breakers (as indicated in single line diagram) shall meet the requirements as specified in annexure-I.</p>			
3.02.00	DUTY REQUIREMENTS			
3.02.01	<p>Circuit breaker shall be restrike free under all duty conditions and shall be capable of performing their duties without opening resistor. The circuit breaker shall meet the duty requirement of any type of fault or fault location and shall be suitable for line charging and dropping when used on 765/ 400/ 220/ 132kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily. The circuit breaker shall meet the requirements of C2/M2 type of duty as per IEC for 765kV & C2/ M1 type of duty as per IEC for 400kV, 220kV</p>			
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	& 132kV.			
3.02.02	The Bidder may note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, pneumatic/hydraulic pressure and arc extinguishing medium pressure, etc. While furnishing the proof of the total break time of complete circuit breaker, the Bidder may specifically bring out the effect of non-simultaneity between same pole and poles and show how it is covered in the guaranteed total break time.			
3.03.00	CONSTRUCTIONAL FEATURES			
3.03.01	All the three poles of the breaker shall be linked together either electrically/pneumatically or electro hydraulically.			
3.03.02	Circuit breakers shall be provided with two (2) independent trip coils, suitable for trip circuit supervision. The trip circuit supervision relay would also be provided. Necessary terminals shall be provided in the central control cabinet of the circuit breaker.			
3.04.00	SULPHUR HEXAFLOURIDE (SF6) GAS CIRCUIT BREAKER			
3.04.01	Circuit breakers shall be single pressure type.			
3.04.02	Each pole shall form an enclosure filled with SF6 gas independent of two other poles. Common monitoring of SF6 gas can be provided for the three poles of circuit breaker having a common drive. The interconnecting pipes in this case shall be such that the SF6 gas from one pole could be removed for maintenance purposes.			
3.04.03	Sufficient SF6 gas shall be supplied to fill all the circuit breakers installed plus an additional 20% of the quantity as spare.			
3.05.00	OPERATING MECHANISM			
3.05.01	Circuit breaker shall be operated by pneumatic mechanism or electrically spring charged mechanism or electro-hydraulic mechanism or a combination of these. It shall be gang operated in case of 3-phase reclosing operation as applicable.			
3.05.02	The pneumatically operated mechanism shall offer unit compressor with each circuit breaker with the breaker local air receivers having a capacity for two ‘CO’ operations of the breaker at the lowest pressure for reclose duty without refilling.			
3.05.03	The Spring operated mechanism shall be complete with motor, opening spring & closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit. As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty. After failure of power supply to the motor, one close-open operation shall be possible with the energy contained in the operating mechanism. Motor ratings shall be such that it requires not more than 30 seconds for fully charging the closing spring.			
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3.05.04	The hydraulic mechanism shall be suitable for at least two close open operations after failure of ac supply to the motor starting at pressure equal to lowest pressure of auto-reclose duty. All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage at a minimum of 1.5 times maximum working pressure.			
3.06.00	FITTINGS AND ACCESSORIES			
3.06.01	The insulators and terminal connectors shall conform to requirements stipulated elsewhere. All routine tests shall be conducted on the insulators as per relevant IEC.			
3.06.02	UNIT COMPRESSED AIR SYSTEM			
a)	The unit compressed air system for each breaker shall be provided with compressed air piping, piping accessories, control and non-return valves, filters, coolers of adequate capacity, pressure reducing valves(if any), isolating valves, drain ports, etc. The air compressor shall be driven by automatically controlled motor. It shall be of air cooled type complete with preferably oil-less cylinder lubrication. The compressors or pumps shall be mounted within the operating mechanism housing or a separate weather-proof and dust-proof housing. Each compressor shall be equipped with a time totaliser.			
b)	The compressor size shall be such that it is capable of performing following operations satisfactorily :			
	i) Total running time of compressor not exceeding 45 minutes per day, considering 2% leakage and 2 CO-operations.			
	ii) Air charging time not exceeding 20 minutes after one CO operation of the breaker.			
c)	Air Receivers:			
	i) The capacity of receivers shall be sufficient for two (2) CO operations of the breaker.			
	ii) Air receiver shall be designed in accordance with the latest edition of the ASME Code for Pressure Vessel - Section VIII of BS:5179. A corrosion allowance of 3.0 mm shall be provided for shell and dished ends. Receivers shall be hot dip galvanized.			
d)	Controls and Control Equipment:			
	i) The compressor control shall be of automatic start stop type initiated by pressure switches on the receiver. Supplementary manual control shall also be provided.			
	ii) All control equipment shall be housed in a totally enclosed cabinet. Pressure gauges and other indicating devices, control switches shall be mounted on the control cabinet.			
	iii) Facility to annunciate failure of power supply to the compressor control shall also be provided.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
e)	Compressed Air Piping, Valves and Fittings:			
	i) The flow capacity of all valves shall be at least 20% greater than the compressor capacity.			
	ii) The high pressure system shall be such that after one 0 - 0.3 Sec - CO operation, the breaker shall be capable of performing one CO operation within 3 minutes.			
	iii) All compressed air piping shall be bright annealed, seamless phosphorous Deoxidized Non-Arsenical Copper alloy or stainless steel pipe (C-106 of BS: 2871).			
3.07.00	TESTS			
3.07.01	Type test			
	a) GIS circuit breaker shall be type tested in accordance with the requirement stipulated under clause no 1.06.02 & 1.06.03.			
3.07.02	Routine Tests			
	Routine tests as per IEC on the complete breaker/ pole along with its own operating mechanism and pole column shall be performed on all circuit breakers.			
3.07.03	SITE TESTS			
	All routine tests except power frequency voltage dry withstand test on breaker shall be repeated on the completely assembled breaker at site.			
3.08.00	PARAMETERS			
3.08.01	General			
	a)	Type of circuit breaker	SF6 insulated	
	b)	Number of poles	Three (3)	
	c)	Rated operating duty cycle	O - 0.3 sec. - CO - 3min. – CO	
	d)	Reclosing	Single and three phase high speed auto reclosing (as required)	
	e)	Total closing time	Not more than 150 ms.	
	f)	Maximum difference in the instants of closing/opening of contacts	As per IEC	
	g)	Trip and closing coil voltage	220V DC	
	h)	Auxiliary contacts	As required plus 10 NO and 10 NC contacts per breaker as spare. The contacts shall have continuous	
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		rating of 10A and breaking capacity of 2A with circuit time constant of minimum 20 millisecond at 220V DC.	
	i) Noise level	Maximum 140dB at 50m distance from base of circuit breaker	
	j) Rated terminal load	Adequate to withstand 100kg static load as well as wind, seismic and short circuit forces without impairing reliability or current carrying capacity.	
	k) Type of operating mechanism	Pneumatic/spring/hydraulic/or a combination of these	
3.08.02	765kV Class Circuit Breakers (GIS)		
	a) Rated voltage	800 kV rms	
	b) Rated continuous current	As per SLD	
	c) Rated short circuit breaking current at rated voltage	50kA with percentage of DC component as per IEC corresponding to minimum opening time under operating conditions specified.	
	d) Symmetrical interrupting Capability	50 kA rms	
	e) Short time current carrying Capability	50 kA rms for One (1) second	
	f) Short circuit making current Capability	125 kAp	
	g) Rated out-of-phase breaking	12.5 kA rms	
	h) Rated line charging breaking Current (voltage factor of 1.4)	900A at 90° C leading power factor with maximum permissible switching overvoltage of 2.0 pu.	
	i) Rated small inductive current Breaking capacity	Corresponding to interrupting steady and transient magnetising current of 1000 MVA transformers and 330MVAR shunt reactor with overvoltage less than 2.0 pu	
	j) First pole to clear factor	1.3	
	k) Rated break time		
		i) 40 ms under test duties 2, 3 & 4 at rated values	
		ii) 45 ms under test duties 1 to 5 and short line fault test duties and combined variation of trip coil voltage, operating pressure and quenching media pressure, etc.	
	l) Rated one minute power	i) 960 kV rms between live terminals and earth.	
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<p>frequency withstand voltage</p> <p>m) Rated lightning impulse withstand voltage</p> <p>n) Rated switching impulse withstand voltage</p> <p>o) Max. radio interference voltage for Frequency between 0.5 MHz and 2MHz at 508kV rms (Micro volts) both in open and closed position</p> <p>p) Partial discharge level</p> <p>q) Pre Insertion Resistor Rating</p>	<p>ii) 1270 kV rms across isolating distance.</p> <p>i) ± 2100 kVp between live terminals and earth. ii) ± 2100 kVp impulse on one terminal and 455 kVp power freq. voltage of opposite polarity on other terminal (across isolating distance).</p> <p>i) ± 1550 kVp between live terminals and earth ii) ± 1175 kVp impulse on one terminal and 653 kVp power freq. voltage of opposite polarity on other terminal (across isolating distance).</p> <p>2500</p> <p>5 Pico coulombs max.</p> <p>450 ohms minimum with pre- insertion time of 9 (+1,-0) millisec. (if required)</p>	
3.08.03	400kV Class Circuit Breakers (GIS)		
	<p>a) Rated voltage</p> <p>b) Rated continuous current current capacity</p> <p>c) Rated short circuit breaking current at rated voltage</p> <p>d) Symmetrical interrupting Capability</p> <p>e) Short time current carrying Capability</p> <p>f) Short circuit making current Capability</p> <p>g) Rated out-of-phase breaking</p> <p>h) Rated line charging breaking Current (voltage factor of 1.4)</p> <p>i) Rated small inductive current</p>	<p>420 kV rms</p> <p>As per SLD</p> <p>50kA with percentage of DC component as per IEC corresponding to minimum opening time under operating conditions specified.</p> <p>50 kA rms</p> <p>50 kA rms for One (1) second</p> <p>125 kAp</p> <p>12.5 kA rms</p> <p>600A at 90° C leading power factor with maximum permissible switching overvoltage of 2.3 pu.</p> <p>As per IEC</p>	
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3.08.04	Breaking capacity		
	j)	First pole to clear factor	1.3
	k)	Rated break time	
		i) 40 ms under test duties 2, 3 & 4 at rated values	
		ii) 45 ms under test duties 1 to 5 and short line fault test duties and combined variation of trip coil voltage, operating pressure and quenching media pressure, etc.	
	l)	Rated one minute power frequency withstand voltage	i) 650 kV rms between live terminals and earth. ii) 815 kV rms across isolating distance and/ or across open switching device
	m)	Rated lightning impulse withstand voltage	i) ±1425 kVp between live terminals and earth. ii) ± 1425 kVp impulse on one terminal and 240 kVp power freq. voltage of opposite polarity on other terminal (across isolating distance).
	n)	Rated switching impulse withstand voltage	i) ± 1050 kVp between live terminals and earth ii) ± 900 kVp impulse on one terminal and 345 kVp power freq. voltage of opposite polarity on other terminal (across isolating distance).
	o)	Partial discharge level	5 Pico coulombs max.
	220 kV CIRCUIT BREAKERS (GIS)		
	a)	Rated voltage	245 kV, rms.
	b)	Rated continuous current at an ambient temperature of 50 ⁰ C	As per SLD
	c)	Symmetrical interrupting Capability	40kA, rms.
d)	Rated short circuit making current	100 kAp	
a)	Short time current carrying Capability for one second	40 kA, rms.	
b)	Out of phase breaking current Capacity	10 kA, rms.	
e)	Rated line charging breaking current At 90 ⁰ leading power factor angle (A, rms.)	As per IEC	
(The breaker shall be able to interrupt the rated line charging current with a test voltage immediately before opening equal to the product of U/√ 3 and 1.4 as per IEC-62271-100).			
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	f) Rated small inductive current Switching capability with over-voltage less than 2.3 p.u. g) Interrupting capability of Transformer steady and transient magnetising current h) First pole to clear factor i) Rated break time Total break time j) Rated Insulation levels: i) Full wave impulse withstand voltage (1.2/50 micro sec.) between line terminals and ground between terminals with circuit breaker open ii) One minute power frequency dry and wet withstand voltage between line terminals and ground between terminals with circuit breaker open k) Max. radio interference voltage for Frequency between 0.5 MHz and 2 MHz at 156 kV rms (Micro volts) both in open and closed position m) Partial discharge level	0.5 to 10 A upto 500 MVA 1.3 60 ms 65 ms ± 1050 kV peak ± 1200 kV impulse on one terminal and other terminal earthed 460 kV rms 530 kV rms 1000	5 Pico coulombs max.
3.08.05	132 kV Class Circuit Breakers (GIS):		
	a) Rated voltage b) Rated continuous current at an ambient temperature of 50° C c) Symmetrical interrupting Capability d) Rated short circuit making current e) Short time current carrying Capability for one second	145 kV, rms. As per SLD 31.5 kA, rms. 80 kAp 31.5 kA, rms.	
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	<p>f) Out of phase breaking current Capacity 7.8 kA, rms.</p> <p>g) Rated line charging breaking current At 90° leading power factor angle (A, rms.) As per IEC (The breaker shall be able to interrupt the rated line charging current with a test voltage immediately before opening equal to the product of $U/\sqrt{3}$ and 1.4 as per IEC-60271-100).</p> <p>h) Rated small inductive current Switching capability with over-voltage less than 2.3 p.u. 0.5 to 10 A</p> <p>i) Interrupting capability of Transformer steady and transient magnetising current up to 500 MVA</p> <p>j) First pole to clear factor 1.5</p> <p>k) Rated breaktime 60 ms</p> <p>l) Total breaktime 65 ms</p> <p>m) Rated Insulation levels : I) Full wave impulse withstand voltage (1.2/50 micro sec.) between line terminals and ground ± 650 kV peak between terminals with circuit breaker open ± 750 kV impulse on one terminal and other terminal earthed II) One minute power frequency dry and wet withstand voltage between line terminals and ground 275 kV rms between terminals with circuit breaker open 315 kV rms</p> <p>n) Max. radio interference voltage for Frequency between 0.5 MHz and 2MHz at 92kV rms (Micro volts) both in open and closed position 1000</p> <p>o) Partial discharge level 5 Pico coulombs max.</p> <p style="text-align: right;">ANNEXURE-I</p> <p style="text-align: center;">Requirement of Controlled Switching Device for Circuit Breaker</p>		
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	<p>The circuit breaker with controlled switching as indicated in single line diagram shall meet the following requirement:</p> <ol style="list-style-type: none"> 1. The Switching controlled Device shall be used to reduce increased over voltages, re ignition between circuit breaker contacts that may be caused by normal switching of high voltage circuit breakers and hence optimize the stresses on circuit breaker while switching the circuit. The switching controlled device will be called device henceforth. 2. The device shall be such that only switching commands (for operating purpose) are processed in the device. Open command triggered by protection on fault shall be forwarded directly to the breaker. In these cases switching instance is not controlled. 3. Circuit breaker should be able to be switched while switching controlled device is not in operation e.g. during maintenance work or power supply is not connected, a bypass shall be provided to the device. In these cases the switching commands will then be forwarded directly to the circuit breaker via this Bypass. The switching time will not be controlled with these switching operations. 4. The device shall have functions for switching ON & OFF the circuit breakers. 5. The controller shall get command to operate the breakers manually or through auto re-close relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate. 6. The device shall also have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command and optimize the switching behavior as necessary. In calculation of next operating time of the breaker the controller must consider all factors that may affect the operating time of the breaker. 7. The device should have display facility at the front for the settings and measured values, alternatively a laptop shall be supplied with each CSD to facilitate display at the front for the setting and measured values. 8. The device shall have self monitoring facility. 9. The device shall be suitable for operation considering transient and dynamic state values of the current and voltage from the secondary of the CTs and CVTs 10. During the switching operations, current and voltage waveforms and other parameters shall be recorded and saved together with calculated values. The control 			
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	<p>switching device provided shall be networked to an Engineering work station (EWS) located in the switchyard control room. It shall be possible to extract the switching oscillographic records and also to do CSD parameterization from this EWS. All necessary software & hardware shall be in bidder's scope.</p> <p>11. It shall have self monitoring facilities. Faults which impair the functioning of the device or peripheral components, failure of trip voltage or sensors shall be displayed visually and shall give alarm.</p> <p>12. The device shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified elsewhere in the specification.</p> <p>13. The device shall have time setting resolution of 0.1 ms or better.</p> <p>14. The device shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering the scheme.</p> <p>15. Supply of all the necessary accessories required for the successful operation of controlled switching device shall be in the scope of supplier of the device.</p> <p>16. Test reports for the following type tests shall be submitted:</p> <ul style="list-style-type: none">a. Dielectric withstand test as per IEC 60255-27.b. High voltage Impulse test as per IEC 60255-27.c. Slow damped oscillatory wave test as per IEC60255-26d. Fast transient test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-4)e. Electrostatic Discharge test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-2)f. Surge Immunity test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-5)g. Power frequency magnetic field test as per IEC 60255-26 (class 5 installation as per base standard IEC 61000-4-8)h. Radiated radio frequency electromagnetic field test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-3)i. Conducted disturbance induced by radio frequency field as as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-6)j. Power frequency immunity test on binary input as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-16)			
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4.00.00	DISCONNECTOR			
4.01.00	GENERAL			
4.01.01	The isolators and accessories shall conform in general to relevant IEC 62271-102 (or equivalent Indian Standard) except to the extent explicitly modified in specification.			
4.01.02	Earth switches shall be provided on isolators as marked on SLD.			
4.01.03	The isolators and earth switches shall be A. C. motor operated.			
4.01.04	Complete disconnecter with all the necessary items for successful operation shall be supplied.			
4.02.00	DUTY REQUIREMENTS			
4.02.01	and thermal effects of the maximum possible short circuit current of the Isolators and earth switches shall be capable of withstanding the dynamic system in their closed position. They shall be constructed such that they do not open under influence of short circuit current, wind pressure and other mechanical loads together. The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa.			
4.02.02	In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of fail safe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated in relevant section. The interlock coil shall be provided with adequate contacts for facilitating permissive logic for 'DC' control scheme of the isolator as well as for AC/DC circuit of the motor to prevent opening or closing of isolators when the interlocking coil is not energised.			
4.02.03	The earthing switches shall be capable of discharging trapped charges of the associated lines. Isolator and earth switches shall be able to bear on the terminals the total forces including wind loading and electrodynamic forces on the attached conductor without impairing reliability or current carrying capacity.			
4.03.00	CONSTRUCTIONAL FEATURES (For GIS)			
a)	The three pole/ Single pole group operated disconnectors shall be operated by electric motor suitable for use on 220 V DC ungrounded system/415V AC system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current & short circuit.			
b)	Disconnectors shall be designed as per relevant IEC. These shall be suitable to make and break the capacitive charging currents during their opening and closing. They shall also be able to make & break loop current which appears during transfer between bus bars. The contact shielding shall also be designed to prevent restrikes			
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	<p>and high local stresses caused by the transient recovery voltages when these currents are interrupted.</p> <p>c) The disconnecting switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.</p> <p>d) It shall be possible to operate the disconnecting switches manually by cranks or hand wheels. The contacts shall be both mechanically and electrically disconnected during the manual operation.</p> <p>e) The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.</p> <p>f) The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the bay module control cabinet.</p> <p>g) Remote control of the disconnectors from the BCU in Relay room & power house control room shall be made through remote / local transfer switch.</p> <p>h) The disconnector operations shall be interlocked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.</p> <p>i) Each disconnector shall be supplied with auxiliary switch having eight normally open and eight normally closed contacts for use by others over and above those required for disconnector operation purposes. The auxiliary switch contacts are to be continuously adjustable such that, when required, they can be adjusted to make contact before the main switch contacts. Additionally MBB contact as required shall also be provided.</p> <p>j) The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely.</p> <p>k) The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.</p> <p>l) All auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10 A DC continuously.</p> <p>m) The auxiliary switches shall be capable of breaking at least 2 A in a 220-V DC circuit with a time constant of not less than 20 milliseconds.</p> <p>n) The disconnectors and safety grounding switches shall have a mechanical key (padlocking key) and electrical interlocks to prevent closing of the grounding</p>		
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	<p>switches when disconnector switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position.</p> <p>o) The local control of the disconnector and high-speed grounding switches from the bay module control panel should be achieved from the individual control switches with the remote/local transfer switch set to local.</p> <p>p) All electrical sequence interlocks will apply in both remote and local control modes.</p> <p>q) Each disconnector shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the bay module control cabinet and provisions for taking the signals to the power house control room. The details of the inscriptions & colouring for the indicator are given as under:</p> <table><tr><td>Sign</td><td>Back ground</td><td>Colour</td></tr><tr><td>Open position</td><td>Open</td><td>Green</td></tr><tr><td>Closed position</td><td>Closed</td><td>Red</td></tr></table> <p>r) All the disconnector and earth switches shall be provided with inspection window so that the travel of the switch contacts in both open and close positions can be verified by visual inspection.</p> <p>s) The disconnecting switches shall be provided with rating plates and shall be accessible for inspection.</p> <p>t) The disconnecting switches shall be capable of being padlocked in both the open and closed positions with the operating motor automatically disengaged. The padlocking device shall be suitable for a standard size lock with a 10mm shank. The padlock must be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.</p>				Sign	Back ground	Colour	Open position	Open	Green	Closed position	Closed	Red
Sign	Back ground	Colour											
Open position	Open	Green											
Closed position	Closed	Red											
4.04.00	SAFETY GROUNDING SWITCHES												
	<p>a) Three-pole/ Single pole, group operated, safety grounding switches shall be operated by electric motor for use on 220V DC ungrounded system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit.</p> <p>b) In order to provide test facilities for CTs, transformers, cables etc., certain ground switches may require to be electrically insulated from the enclosures and have easily removable ground connections.</p> <p>c) Each safety grounding switch shall be electrically interlocked with its associated disconnector and circuit breaker such that it can only be closed if both the circuit breaker and disconnector are in open position. Safety grounding switch shall however be mechanically key interlocked with its associated disconnector.</p> <p>d) Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal to Power House Control Room.</p>												
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
e)	The details of the inscription and colouring for the indicator are given as under:			
	Sign	Background	Colour	
	Open position	Open	Green	
	Closed position	Closed	Red	
f)	Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits.			
g)	Each ground switch shall be fitted with auxiliary switches having six normally open and six normally closed contacts for use by others over and above those required for local interlocking and position indication purposes.			
h)	Provision shall be made for padlocking the ground switches in either the open or closed position.			
i)	All portions of the grounding switch and operating mechanism required for grounding shall be connected together utilizing flexible copper conductors having a minimum cross-sectional area of 50 mm2.			
j)	The main grounding connections on each grounding switch shall be rated to carry the full short circuit rating of the switch for 1 s and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid.			
k)	The safety grounding switches shall conform to the requirements of IEC 62271-102			
l)	Mechanical position indication shall be provided locally at each switch along with remote indication at each bay module control cabinet & in the power house control room.			
4.05.00	HIGH SPEED GROUNDING SWITCHES			
a)	Grounding switches located at the beginning of the Feeder bay modules shall be of the high-speed and will be used to discharge the respective charging currents, in addition to their safety grounding function. These grounding switches shall also be capable of interrupting the inductive currents and to withstand the associated TRV.			
b)	Single phase switches shall be provided with individual/group operated mechanism operating mechanism for each phase suitable for operation from a 220V DC ungrounded supply.			
c)	The switches shall be fitted with a stored energy closing system to provide fault making capability.			
d)	The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating of 125KA. The switches shall have inductive / capacitive current switching capability as per IEC-62271-102.			
e)	Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay			
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CLAUSE NO.	TECHNICAL REQUIREMENTS												
	<p>module control cabinet and provision for taking the signal to Power House Control Room.</p>												
f)	<p>The details of the inscription & coloring for the indicator shall be as under:</p> <table><tr><td>Sign</td><td>Background</td><td>Colour</td></tr><tr><td>Open position</td><td>Open</td><td>Green</td></tr><tr><td>Closed position</td><td>Closed</td><td>Red</td></tr></table>				Sign	Background	Colour	Open position	Open	Green	Closed position	Closed	Red
Sign	Background	Colour											
Open position	Open	Green											
Closed position	Closed	Red											
g)	<p>High-speed ground switch operation should be possible locally from the bay module control cabinet, or remotely from the relay room & power house control room in conjunction with opening of the associated disconnecter.</p>												
h)	<p>These high-speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches can not be closed if the circuit breakers and disconnectors are closed.</p>												
i)	<p>Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.</p>												
j)	<p>Each high speed ground switch shall be fitted with auxiliary switches having six normally open(NO) and six normally closed (NC) auxiliary contacts for use by others, over and above those required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the local bay control cabinet. Provision shall be made for padlocking the grounding switches in either the open or closed position.</p>												
k)	<p>All portion of the grounding switches and operating mechanism required for connection to ground shall be connected together utilizing flexible copper conductor having minimum cross-sectional area of 50 sq mm.</p>												
l)	<p>The main grounding connection on each grounding switch shall be rated to carry the peak withstand current rating of the switch for 1 sec and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate design for connection to the grounding grid.</p>												
m)	<p>The high speed grounding switches shall conform to the requirements of IEC-62271-102.</p>												
4.06.00	CONSTRUCTIONAL FEATURES (For AIS)												
a)	<p>The isolators shall be provided with high pressure current carrying contacts on the hinge/ jaw ends and all contact surfaces shall be silver plated. The thickness of silver plating wherever provided should not be less than 25 microns.</p>												
b)	<p>The isolator shall be provided with a galvanised steel base provided with holes and designed for mounting on a lattice/pipe support structure. The base shall be rigid and self supporting. The position of movable contact system (main blades) of each of the isolator and earthing switch shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the isolator and earthing switch. The indicator shall be of metal and shall be visible from operating level.</p>												
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CLAUSE NO.	TECHNICAL REQUIREMENTS
<p>c)</p> <p>d)</p> <p>e)</p>	<p>All metal parts shall be of non-rusting and non-corroding metal. Current carrying parts shall be from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities, if provided on current carrying parts, shall be made of copper silicon alloy or equivalent. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces.</p> <p>The isolators shall be so constructed that the switch blade will not fall to the closed position if the operating shaft gets disconnected. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by gravity, wind pressure, vibrations shocks or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals.</p> <p>The insulator of the isolator shall conform to the requirements stipulated elsewhere and shall have a min. cantilever strength of 800 kg for 400 kV isolator.</p>
4.07.00	<p>EARTHING SWITCHES (For AIS)</p>
	<p>Where earthing switches are specified these shall include the complete operating mechanism and auxiliary contacts. The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator. Earthing switches shall be suitable for local operation only. The earthing switches shall be constructional interlocked with the isolator so that the earthing switches can be operated only when isolator is open and vice versa.</p>
4.08.00	<p>OPERATING MECHANISM AND CONTROL (For AIS)</p>
4.08.01	<p>The Contractor shall offer, motor operated switches having padlock arrangement for both 'ON' and 'OFF' positions.</p>
4.08.02	<p>Limit switches for control shall be fitted on the isolator/ earth switch shaft, within the cabinet to sense the open and close positions of the isolators and earth switches.</p>
4.08.03	<p>It shall not be possible, after final adjustment has been made for any part of the mechanism to be displaced at any point in the travel sufficient enough to allow improper functioning of the isolator when the isolator is opened or closed at any speed.</p>
4.08.04	<p>Control cabinet/operating mech. box shall conform to requirements stipulated under auxiliary part and IS:5039/IS 8623/IEC 60439 as applicable.</p>
4.09.00	<p>OPERATION (For AIS)</p>
4.09.01	<p>Isolator shall be electrically/mechanically gang operated for main blades and earth switches. The operation of the three poles shall be well synchronised and interlocked.</p>
4.09.02	<p>The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection. The length of inter insulator and interpole operating rods shall be capable of adjustments.</p>
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
4.09.03	The design of linkages and gears be such so as to allow one man to operate the handle with ease for isolator and earth switch.		
4.10.00	TESTS		
4.10.01	The GIS disconnecter shall be type tested in accordance with the requirement stipulated under clause no 1.06.02 & 1.06.03.		
4.10.02	In continuation to the requirements stipulated under clause no.1.06.01 the isolator along with operating mechanism (AIS) shall conform to the type tests and shall be subjected to routine tests and acceptance tests in accordance with IEC 62271-102. Minimum 50 nos. mechanical operations will be carried out on 1 (one) isolator of each type assembled completely with all accessories as acceptance test. During final testing of isolator sequential closing/ opening of earth switch shall also be checked only after isolator is fully open/close.		
4.10.03	<p>The insulator (AIS) shall conform to all the type tests as per IEC 60168. In addition to all type, routine and acceptance tests, as per IEC-60168, the following additional routine/ acceptance tests shall also be carried out:</p> <ul style="list-style-type: none"> a) Bending load test in four directions at 50% min. bending load guaranteed in all insulators. b) Bending load test in four directions at 100% min. bending load guaranteed on sample insulators in a lot. c) Torsional test on sample insulator of a lot. 		
4.11.00	PARAMETERS		
4.11.01	General		
	<ul style="list-style-type: none"> a) Type of isolator <ul style="list-style-type: none"> Metal enclosed, SF6 Gas Insulated (For GIS) Outdoor type (For AIS) b) Number of poles <ul style="list-style-type: none"> Three (3) d) Operating time <ul style="list-style-type: none"> Not more than 12 sec. e) Control voltage <ul style="list-style-type: none"> 220V DC f) Auxiliary contacts on Isolator <ul style="list-style-type: none"> Minimum 8NO and 8NC contacts per pole/isolator shall be provided. The contacts shall have continuous rating of 10A and breaking capacity of 2A with circuit time constant of minimum 20 millisecond at 220V dc. Additionally MBB contacts as required shall also be provided. g) Auxiliary contacts on earth switch/ safety grounding switch/high speed <ul style="list-style-type: none"> Total 6NO and 6NC 		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	fault making switch			
	h)	Rated mechanical terminal load	As per table III of IEC 62271-102 (For AIS)	
	i)	Temperature rise over ambient	As per IEC:62271-102	
	j)	Operating mechanism of isolator and earth switch	AC/DC/Universal motor operated	
4.11.02	765kV Class Isolators (GIS)			
	a)	Rated voltage	800 kV rms	
	b)	Rated continuous current	As per SLD	
	c)	Rated short time withstand current of isolator and earthswitch	50 kA rms for One (1) second	
	d)	Rated dynamic short circuit withstand current of isolator and earthswitch	125 kAp	
	e)	Rated Insulation levels		
		i. Rated one minute power Frequency withstand voltage	i) 960 kV rms between live terminals and earth. ii) 1270 kV rms across isolating distance.	
		ii. Rated lightning impulse Withstand voltage	i) ± 2100 kVp between live terminals and earth. ii) ± 2100 kVp impulse on one terminal and 455 kVp power freq. Voltage of opposite polarity on other terminal (across isolating distance).	
		iii. Rated switching impulse Withstand voltage	i) ± 1550 kVp between live terminals and earth. ii) ± 1175 kVp impulse on one terminal and 650 kVp power freq. voltage of opposite polarity on other terminal (across isolating distance).	
	f)	Max. Radio interference voltage	2500 micro volts for freq. between 0.5 MHz and 2.0 MHz at voltage 508kV rms.	
	g)	Partial discharge level at $1.1 U_n/\sqrt{3}$	5 pico coulombs	
4.11.03	400kV Class Isolators (GIS)			
	a)	Rated voltage	420 kV rms	
	b)	Rated continuous current	As per SLD	
	c)	Rated short time withstand current of isolator and earth switch	50 kA rms for One (1) second	
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
4.11.04	d)	Rated dynamic short circuit withstand 125 kAp current of isolator and earth switch		
	e)	Rated Insulation levels		
	i.	Rated one minute power Frequency withstand voltage	i) 650 kV rms between phase to earth & between phases. ii) 815 kV rms across isolating distance and/or open switching device	
	ii.	Rated lightning impulse Withstand voltage	i) ±1425 kVp between live terminals and earth. ii) ± 1425 kVp impulse on one terminal and 240 kVp power freq. Voltage of opposite polarity on other terminal (across isolating distance).	
	iii.	Rated switching impulse Withstand voltage	i) ± 1050 kVp between live terminals and earth. ii) ± 900 kVp impulse on one terminal and 345 kVp power freq.voltage of opposite polarity on other terminal (across isolating distance).	
	f)	Partial discharge level at 1.1 Un/√3	5 pico coulombs	
	220 kV ISOLATORS (GIS) :			
	a)	Normal system voltage	220 kV	
	b)	Highest system voltage	245 kV	
	c)	Rated current at 50 ⁰ C ambient Temperature	As per SLD	
d)	Rated short time withstand Current of isolator and earth switch	40kArms for 1 sec.		
e)	Rated dynamic short circuit withstand Current of isolator and earth switch	100 kA (Peak)		
f)	Rated insulation levels:			
		1.2/50 micro sec. lightning impulse withstand voltage (+ ve or – ve polarity) impulse on one terminal and other terminal earthed	One minute power frequency withstand voltage (Between live terminal and earth)	
	To earth	± 1050 kV (Peak)	460 kV (rms)	
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	<p>Across isolating distance ± 1200 kV peak 530 kV (rms)</p> <p>g) Max. Radio interference voltage 1000 micro volts for frequency between 0.5 MHz to 2.0 MHz at 156 kV (rms)</p> <p>h) Partial discharge level at $1.1 U_n/\sqrt{3}$ 5 pico coulombs</p> <p>4.11.05 132 kV Class Isolators (GIS):</p> <p>a) Normal system voltage 132 kV</p> <p>b) Highest system voltage 145 kV</p> <p>c) Rated current at 50° C ambient Temperature As per SLD</p> <p>d) Rated short time withstand Current of disconnector/isolator and earth switch 31.5 kA for 1 sec.</p> <p>e) Rated dynamic short circuit withstand Current of disconnector/isolator and earth switch 80 kA (Peak)</p> <p>f) Rated insulation levels :</p> <p style="text-align: center;">1.2/50 micro sec lightning impulse withstand voltage (+ve or –ve polarity) (impulse on one terminal and Other terminal earthed)</p> <p style="text-align: right;">One minute over frequency withstand voltage (Between live terminal and earth)</p> <p>To earth ± 650 kV (Peak) 275 kV (rms)</p> <p>Across isolating distance ± 750 kV (Peak) 315 kV (rms)</p> <p>g) Radio interference level for 0.5 MHz to 2.0 MHz 1000 microvolts (Max.) at 92 kV (rms) between phase and ground</p> <p>h) Partial discharge level at $1.1 U_n/\sqrt{3}$ 5 pico coulombs</p> <p>4.11.06 33 kV Class Isolators (AIS):</p> <p>a) Rated voltage 36kV rms</p> <p>b) Rated continuous current AS per SLD</p>		
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CLAUSE NO.	TECHNICAL REQUIREMENTS
	<p>c) Rated short time withstand current of isolator and earthswitch 25 kA rms for One (1) second</p> <p>d) Rated dynamic short circuit withstand current of isolator and earthswitch 62.5 kAp</p> <p>e) Rated Insulation levels</p> <p>i. Rated one minute power Frequency withstand Voltage (dry & wet) 70 kV rms</p> <p>ii. Rated lightning impulse Withstand voltage ± 170 kVp</p> <p>f) Minimum total creepage distance (mm) 1260</p>
5.00.00	INSTRUMENT TRANSFORMER
5.01.00	<p>CODES AND STANDARDS</p> <p>Current transformers IEC 61869-2, BS: 3938, IS: 2705</p> <p>Voltage transformers IEC 60044-2&5, IEC 60358, IS: 3156</p> <p>Insulating oil IS: 335</p>
5.02.00	<p>GENERAL REQUIREMENTS (FOR GIS)</p> <p>a) The current transformers and accessories shall conform to IEC-61869-2 and other relevant standards except to the extent explicitly mentioned in the specification.</p> <p>b) The instrument transformers i.e. current and voltage transformers shall be single phase transformer units.</p> <p>c) Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.</p> <p>d) The particulars of the various cores are given here for tender purpose and may change within reasonable limits as per the requirements of protection relays. The contractor is required to submit the VA burden calculations and obtain approval from the Employer before proceeding with design of the cores. The other characteristics of CTs shall be as given below:</p>
5.03.00	PARAMETERS AND CONSTRUCTION DETAILS (GIS)
5.03.01	<p>GENERAL FOR CURRENT TRANSFORMER (GIS)</p> <p>(a) One minute power frequency Withstand voltage between Secondary terminal and earth 5 kV</p> <p>(b) Partial discharge level 10 pico Coulombs max.</p>
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	(c)	Temperature rise	As per IEC
	(d)	Type of insulation	Class A
	(e)	Number of cores	Details are given in table below
	(f)	Rated frequency	50 Hz
	(g)	System neutral earthing	Effectively earthed
	(h)	Number of terminals in box	All terminals of control circuits wired marshalling up to marshalling box plus 20 terminals spare.
	(i)	Rated extended primary current	120% of rated primary current
5.03.02(a)	765 kV Current Transformers (GIS)		
	(a)	Rated dynamic current	125 kA (peak)
	(b)	Rated short time thermal current	50 kA for 1 sec.
	(c)	Rated system voltage (Um)	800 kV (rms)
5.03.02 (b)	400 kV Current Transformers (GIS)		
	(a)	Rated dynamic current	125 kA (peak)
	(b)	Rated short time thermal current	50 kA for 1 sec.
	(c)	Rated system voltage (Um)	420 kV (rms)
5.03.02 (c)	220 kV Current Transformers (GIS)		
	(a)	Rated dynamic current	100 kA (peak)
	(b)	Rated short time thermal current	40 kA for 1 sec.
	(c)	Rated system voltage (Um)	245 kV (rms)
5.03.02(d)	132 kV Current Transformers (GIS)		
	(a)	Rated dynamic current	80 kA (peak)
	(b)	Rated short time thermal current	31.5 kA for 1 sec.
	(c)	Rated system voltage (Um)	145 kV (rms)
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
5.03.03	Construction Details <ul style="list-style-type: none"> a) The current transformers incorporated into the GIS will be used for protective relaying and metering. The secondary windings shall be air/gas insulated. All the current transformers shall have effective electromagnetic shields to protect against high frequency transients. b) Each current transformer shall be equipped with a marshalling box with terminals for the secondary circuits, which are connected to the local control cubicle. The star / delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle. c) Rating and Diagram Plates shall be as specified in the IEC specification incorporating the year of manufacture. The rated extended current rating voltage and rated thermal current shall also be marked on the name plate. The diagram plate shall show the terminal markings and relative physical arrangement of the current transformer cores with respect to the primary terminals(P1 & P2) d) The position of each primary terminal in the current transformer SF₆ gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer. e) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores. f) The current transformers shall be suitable for high speed auto reclosing. g) Electro magnetic shields to be provided against high frequency transients typically 1-30 MHz. h) The wiring between each CT and bay module control cabinet shall be included in the scope of supply. i) Provision shall be made for primary current injection testing of current transformers. 		
5.04.00	BUS VOLTAGE TRANSFORMERS (GIS)		
5.04.01	General <ul style="list-style-type: none"> a) The voltage transformers and accessories shall conform to IEC and other relevant standards except to the extent explicitly mentioned in the specification. b) Voltage transformers shall be of the electro magnetic type with SF₆ gas insulation. The earth end of high voltage winding and the ends of secondary winding shall be brought out in the terminal box. c) The rating and diagram plate shall be provided complying with the requirement of IEC specification incorporating the year of manufacture and including turn's ratio, voltage ratio, burden, connection diagram etc. d) The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of SF₆ switchgear. 		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
e)	All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.			
f)	The transformer shall be able to sustain full line voltage without saturation of transformer.			
g)	Core details are given in table.			
5.04.03	Constructional Details			
a)	The voltage transformers shall be located in a separate bay module on the bus and will be connected phase-to ground and shall be used for protection, metering and synchronizing			
b)	The voltage transformers shall be of induction type, nonresistant and shall be contained in their own- SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The voltage transformers shall have three secondary windings.			
	The voltage transformer secondaries shall be wired by Contractor to their associated bay control cabinets			
5.05.00	GENERAL REQUIREMENTS (For AIS)			
5.05.01	The instrument transformers i.e. current and voltage transformers shall be single phase transformer units and shall be supplied with a common marshaling box for a set of three single phase units.			
5.05.02	All exposed mild steel shall be hot dip galvanised or painted with Grey color of shade RAL 9002.			
5.05.03	The instrument transformers shall be hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs.			
5.05.04	Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.			
5.05.05	The insulators shall have a cantilever strength of more than 500 kg.			
5.05.06	No oil shall come into direct contact with Zinc galvanized surface.			
5.06.00	CURRENT TRANSFORMERS (For AIS)			
5.06.01	The CTs shall have single primary of either ring type or hair pin type or bar type.			
5.06.02	The CT shall be provided with oil level indicator which should be clearly visible to maintenance personnel standing on ground.			
5.06.03	The core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloys. The cores shall produce undistorted secondary current under			
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CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
	transient conditions at all ratios with specified parameters. The CTs shall be suitable for high speed auto-reclosing.		
5.06.04	Different ratios shall be achieved by secondary taps only, and primary reconnections shall not be accepted.		
5.06.05	The guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.		
5.06.06	The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CT/reactor is used, then all parameters specified shall be met treating auxiliary CTs/reactors as integral part of CT. The auxiliary CT/reactor shall preferably be in-built construction of the CT. In case it is separate, it shall be mounted in secondary terminal box.		
5.06.07	The physical disposition of protection secondary cores shall be in the same order as given under CT requirement table(s) given below.		
5.06.08	The secondary terminals shall be terminated on stud type suitable no's of non-disconnecting and disconnecting terminal blocks inside the terminal box of degree of protection IP:55 at the bottom of CT.		
5.06.09	The CTs shall have provision for taking oil samples from bottom of CT without exposure to atmosphere to carry out dissolved gas analysis periodically. Contractor shall give his recommendations for such analysis, i.e. frequency of test, norms of acceptance, quantity of oil to be withdrawn, and treatment of CT.		
5.06.10	The CT shall have provision for measurement of capacitance and tan delta as erected at site.		
5.07.00	VOLTAGE TRANSFORMERS (CVTs) (AIS)		
5.07.01	Voltage transformers shall be of capacitor voltage divider type with electromagnetic unit.		
5.07.02	The CVTs shall be thermally and dielectrically safe when the secondary terminals are loaded with guaranteed thermal burdens.		
5.07.03	The electro-magnetic unit (EMU) shall comprise of compensating reactor, intermediate transformer, and protective and damping devices. The oil level indicator of EMU with danger level marking shall be clearly visible to maintenance personnel standing on ground.		
5.07.04	The secondaries shall be protected by HRC cartridge type fuses for all windings In addition fuses shall also be provided for protection and metering windings for connection to fuse monitoring scheme. The secondary terminals shall be terminated on stud type non-disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP: 55. The access to secondary terminals shall be without the danger of access to high voltage circuit.		
5.07.05	The protection cores shall not saturate at about 1.5 times the rated voltage for a min. duration of 30 secs.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
5.08.00	MARSHALLING BOX		
5.08.01	Marshaling box shall conform to all requirements as given in part auxiliary. The wiring diagram for the interconnection of three phase instrument transformer shall be pasted inside the box. Terminal blocks in the marshaling box shall have facility for star/delta formation, short circuiting and grounding of secondary terminals. The box shall have enough terminals to wire all control circuits plus 20 spare terminals.		
5.09.00	PARAMETERS FOR CURRENT TRANSFORMERS (For AIS)		
5.09.01	General Parameters		
	a) One minute power frequency withstand voltage between secondary terminal and earth	5 kV	
	b) Partial discharge level	10 pico Coulombs max.	
	c) Temperature rise	As per IEC	
	d) Type of insulation	Class A	
	e) Number of cores	Details are given in table below.	
	f) Installation	Outdoor (up right)	
	g) Number of terminals in marshalling box	All terminals of control circuits wired upto marshalling box plus 20 terminals spare.	
5.09.02	33 kV Current Transformers (Oil filled type) (For AIS)		
	a) Highest System Voltage	36 kV	
	b) Rated short time thermal current	25 kA for 1 sec.	
	c) Rated dynamic current	62.5kA (Peak)	
	d) Rated insulation level :		
	i) 1.2/50 micro seconds (impulse voltage)	170 kV (Peak)	
	ii) 1 minute (dry and wet) power frequency withstand voltage	70 kV (rms)	
	e) Rated extended primary current	120% of rated primary current as per SLD	
	f) Minimum total creepage distance (mm)	1260	
5.10.00	PARAMETERS FOR VOLTAGE TRANSFORMERS (FOR AIS)		
5.10.01	General Parameters		
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	a) Installation b) Standard reference range of frequencies for which the accuracies are valid c) High frequency capacitance for frequency range d) Equivalent resistance over entire carrier frequency range e) Stray capacitance and stray conductance of LV terminal over entire carrier frequency range f) One minute power frequency withstand voltage a) between LV (HF) terminal b) For secondary winding g) Temp. rise over an ambient temp. of 50 deg. C h) Number of terminals in control Cabinet i) Rated total thermal burden j) Partial discharge level k) Number of cores l) Rated Voltage factor m) Minimum total creepage distance (mm)	Outdoor 96% to 102% for protection and 99% to 101% for measurement. Within 80% to 150% of rated entire carrier capacitance Less than 40 ohms As per IEC:60358 10kV rms(for 400kV) and earth for exposed terminals or 4 kV rms (for 400kV) for terminals enclosed in a weather proof box. 2 kV rms As per IEC All terminals of control circuits wired upto marshalling box plus 10 terminals spare. 750 VA 10 pico Coulombs max. As per details given in Tables below. 1.2 continuous, 1.5 – 30sec 28000/ 14700/ 8575 for 765kV/ 400kV/ 220kV respectively.	
5.10.02	765 kV CVT (AIS)		
	a) Rated system voltage b) Rated insulation levels i) One minute power frequency withstand voltage ii) 1.2/ 50 micro sec. impulse	800 kV (rms) 975kV rms 2100kV (peak)	
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	ii) 250/2500 micro sec. switching surge withstand voltage (dry & wet) c) Radio Interference voltage at 508 kV at frequency range 0.5 to 2 MHz(rms) d) Corona extinction voltage (min.) e) HF Capacitance	1550 kV (peak) 2500 micro volts (max.) 508 kV (rms) 4400 pf / 8800pf (nominal)	
5.10.03	400kV CVT (AIS)		
	a) Rated system voltage b) Rated insulation levels i) One minute power frequency withstand voltage ii) 1.2/ 50 micro sec. impulse ii) 250/2500 micro sec. switching surge withstand voltage (dry & wet) c) Radio Interference voltage at 266 kV at frequency range 0.5 to 2 MHz(rms) d) Corona extinction voltage (min.) e) HF Capacitance	420 kV (rms) 630kV rms 1425kV (peak) 1050 kV (peak) 1000 micro volts (max.) 320 kV (rms) 4400 pf / 8800pf (nominal)	
5.10.04	220 kV CVT (AIS)		



CLAUSE NO.	TECHNICAL REQUIREMENTS		
5.10.04	<p>TESTS</p> <p>a) GIS Instrument transformer shall be type tested in accordance with the requirement stipulated under clause no 1.06.02 & 1.06.03.</p> <p>b) The current and voltage transformers (For AIS) shall confirm to type tests and subjected to routine tests in accordance with the relevant IEC/IS and shall also conform to the following additional type tests as applicable:</p> <ul style="list-style-type: none"> i) Radio Interference voltage test ii) Corona test (for 765kV & 400kV) iii) Thermal withstand test i.e. application of rated voltage and rated current simultaneously by synthetic test circuit. (for CT only) iv) Seismic withstand test along with structure (for 765kV & 400kV only) v) Thermal co-efficient test i.e. measurement of Tan-Delta as function of temperature (at ambient and between 80 deg. C and 90 deg. C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um).(for CT only) vi) Multiple chopped impulse test on Primary winding. 		
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CLAUSE NO.

TECHNICAL REQUIREMENTS

CORE DETAILS

CORE DETAILS OF 765kV CTs – 3000A (Set - 1)						TABLE – IA	
CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Bus Differential	3000/ 2000/ 1000/500/1	-----	PS	3000/2000/1000/500V	15/ 10/ 5/ 2.5 Ohm	20/ 30/ 60/ 120
2	Bus Differential	3000/ 2000/ 1000/500/1	-----	PS	3000/2000/1000/500V	15/ 10/ 5/ 2.5 Ohm	20/ 30/ 60/ 120
CORE DETAILS OF 765kV CTs – 3000A (Set - 2)						TABLE – IB	
CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Metering & Synchronising.	3000/ 2000/ 1000/ 500/1	20 / 20 / 20 / 20	0.2S	-----	-----	-----
2	Transf. backup/ Line Protection	3000/ 2000/ 1000/ 500/1	-----	PS	4500/3000/1500/ 750V	15/ 8/ 4/ 2 Ohm	20/ 30/ 60/ 120
3	Transf. backup/ Line Protection	3000/ 2000/ 1000/ 500/1	-----	PS	4500/3000/1500/ 750V	15/ 8/ 4/ 2 Ohm	20/ 30/ 60/ 120
ISF for metering core should be less than 10. The rated extended primary current of the CTs shall be 120% continuous of 3000A. Physical arrangement of CTs shall be as per Protection SLD.							

CORE DETAILS OF 765kV VTs (GIS)				TABLE – II	
Secondary Winding	Application	Rated Voltage (V)	Secondary Accuracy	Rated Burden (min)	Secondary VA*
I	Protection	110/v3	3P	50 VA	
II	Protection	110/v3	3P	50 VA	
III	Metering	110/v3	0.2	50 VA	
The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 75 VA on all the three windings without any adjustments during operation.					



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TECHNICAL REQUIREMENTS

* This is minimum burden specified, however bidder to consider VA burden to suit the requirement of the offered system. The supporting calculation to be furnished during detail engineering.

CORE DETAILS OF 7650kV CVTs (AIS)

TABLE – III

Secondary Core	Application	Rated Voltage (V)	Secondary Accuracy	Output Minimum	Burden –
I	Protection	110/v3	3P	50 VA	
II	Protection	110/v3	3P	50 VA	
III	Metering	110/v3	0.2	50 VA	

The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 75 VA on all the three windings without any adjustments during operation.

CORE DETAILS OF 400kV CTs – 3000A (Set - 1)

TABLE – IVA

CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Bus Differential	3000/ 2000/ 1000/1	-----	PS	3000/2000/1000V	15/ 10/ 5 Ohm	20/ 30/ 60
2	Bus Differential	3000/ 2000/ 1000/1	-----	PS	3000/2000/1000V	15/ 10/ 5 Ohm	20/ 30/ 60

CORE DETAILS OF 400kV CTs – 3000A (Set - 2)

TABLE – IVB

CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Metering & Synchronising.	3000/ 2000/ 1000/ 500/1	20 / 20 / 20 / 20	0.2S	-----	-----	-----
2	Transf. backup/ Line Protection	3000/ 2000/ 1000/ 500/1	-----	PS	6000/4000/2000/1000V	15/ 10/ 5/ 2.5 Ohm	20/ 30/ 60/ 120
3	Transf. backup/ Line Protection	3000/ 2000/ 1000/ 500/1	-----	PS	6000/4000/2000/1000V	15/ 10/ 5/ 2.5 Ohm	20/ 30/ 60/ 120

ISF for metering core should be less than 5. The rated extended primary current of the CTs shall be 120% continuous of 3000A. Physical arrangement of CTs shall be as per Protection SLD.



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TECHNICAL REQUIREMENTS

CORE DETAILS OF 400kV VTs (GIS)					TABLE -V
Secondary Winding	Application	Rated Voltage (V)	Secondary Accuracy	Rated Burden (min) VA*	Secondary VA*
I	Protection	110/v3	3P	75 VA	
II	Protection	110/v3	3P	75 VA	
III	Metering	110/v3	0.2	75 VA	

The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 150 VA on all the three windings without any adjustments during operation.

* This is minimum burden specified, however bidder to consider VA burden to suit the requirement of the offered system. The supporting calculation to be furnished during detail engineering.

CORE DETAILS OF 400kV CVTs (AIS)					TABLE - VI
Secondary Core	Application	Rated Voltage (V)	Secondary Accuracy	Output Burden - Minimum	
I	Protection	110/v3	3P	75 VA	
II	Protection	110/v3	3P	75 VA	
III	Metering	110/v3	0.2	75 VA	

The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 150 VA on all the three windings without any adjustments during operation.

CORE DETAILS OF 220kV CTs – 1600A (Set - 1)						TABLE – VIIA	
CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Bus Differential	1600/ 800/1	-----	PS	1600/800 V	8/ 4 Ohm	30/ 60
2	Bus Differential	1600/ 800/1	-----	PS	1600/800 V	8/ 4 Ohm	30/ 60

CORE DETAILS OF 220kV CTs – 1600A (Set - 2)						TABLE – VIIIB	
CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Metering & Synchronising.	1600/ 800/ 400/200/1	20 / 20 / 20/ 20	0.2S	-----	-----	-----



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TECHNICAL REQUIREMENTS

2	Transf. backup/ Line Protection	1600/ 800/ 400/ 200/1	-----	PS	3200/ 1600/800 /400V	8/ 4/ 2/ 1 Ohm	30/ 60/ 120/ 240
3	Transf. backup/ Line Protection	1600/ 800/ 400/ 200/1	-----	PS	3200/ 1600/800 /400V	8/ 4/ 2/ 1 Ohm	30/ 60/ 120/ 240

ISF for metering core should be less than 5. The rated extended primary current of the CTs shall be 120% continuous of 1600A. Physical arrangement of CTs shall be as per Protection SLD.

CORE DETAILS OF 220kV CTs - 2500A (Set - 1) For Bus Section/Bus Coupler Bays

TABLE - VIIIA

CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Bus Differential	2500/ 1250/1	-----	PS	2500/125 0V	12.5/ 6.25 Ohm	30/ 60
2	Bus Differential	2500/ 1250/1	-----	PS	2500/125 0V	12.5/ 6.25 Ohm	30/ 60

CORE DETAILS OF 220kV CTs - 2500A (Set - 2) For Bus Section/Bus Coupler Bays

TABLE - VIIIB

CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Metering & Synchronising.	2500/ 1250/1	20/ 20	0.2S	-----	-----	-----
2	Transf. backup/ Line Protection	2500/ 1250/1	-----	PS	2500/125 0V	12.5/ 6.25 Ohm	30/ 60
3	Transf. backup/ Line Protection	2500/ 1250/1	-----	PS	2500/125 0V	12.5/ 6.25 Ohm	30/ 60

ISF for metering core should be less than 5. The rated extended primary current of the CTs shall be 120% continuous of 2500A. Physical arrangement of CTs shall be as per Protection SLD.



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TECHNICAL REQUIREMENTS

CORE DETAILS OF 220kV VTs (GIS)					TABLE -IX	
Secondary Winding	Application	Rated Voltage (V)	Secondary Accuracy		Rated Burden (min)	Secondary VA*
I	Protection	110/v3	3P		75 VA	
II	Protection	110/v3	3P		75 VA	
III	Metering	110/v3	0.2		75 VA	

The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 150 VA on all the three windings without any adjustments during operation.

* This is minimum burden specified, however bidder to consider VA burden to suit the requirement of the offered system. The supporting calculation to be furnished during detail engineering.

CORE DETAILS OF 220kV CVTs (AIS)					TABLE - X	
Secondary Core	Application	Rated Voltage (V)	Secondary Accuracy		Output Burden - Minimum	
I	Protection	110/v3	3P		75 VA	
II	Protection	110/v3	3P		75 VA	
III	Metering	110/v3	0.2		75 VA	

The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 150 VA on all the three windings without any adjustments during operation.

CORE DETAILS OF 132kV CTs – 1200A (Set - 1)						TABLE – XIA	
CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Bus Differential	1200/ 600/1	-----	PS	1200/600 V	6/ 3 Ohm	30/ 60
2	Bus Differential	1200/ 600/1	-----	PS	1200/600 V	6/ 3 Ohm	30/ 60

CORE DETAILS OF 132kV CTs – 1200A (Set - 2)						TABLE – XIB	
CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Metering & Synchronising.	1200/ 600/ 300/1	20 / 20 / 20	0.2S	-----	-----	-----



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2	Transf. backup/ Line Protection	1200/ 600/ 300/1	-----	PS	1200/ 600/300V	6/ 3/ 1.5 Ohm	30/ 60/ 120
3	Transf. backup/ Line Protection	1200/ 600/ 300/1	-----	PS	1200/ 600/300V	6/ 3/ 1.5 Ohm	30/ 60/ 120

ISF for metering core should be less than 5. The rated extended primary current of the CTs shall be 120% continuous of 1200A. Physical arrangement of CTs shall be as per Protection SLD.

CORE DETAILS OF 132kV CTs – 2000A (Set - 1) For Bus Section/ Bus Coupler Bays

TABLE – XIIA

CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Bus Differential	2000/ 1000/1	-----	PS	2000/100 0V	10/ 5 Ohm	30/ 60
2	Bus Differential	2000/ 1000/1	-----	PS	2000/100 0V	10/ 5 Ohm	30/ 60

CORE DETAILS OF 132kV CTs – 2000A (Set - 2) For Bus Section/ Bus Coupler Bays

TABLE – XIIB

CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Metering & Synchronising.	2000/ 1000/ 500/1	20 / 20 / 20	0.2S	-----	-----	-----
2	Transf. backup/ Line Protection	2000/ 1000/ 500/1	-----	PS	2000/ 1000/ 500/V	10/ 5/ 2.5 Ohm	30/ 60/ 120
3	Transf. backup/ Line Protection	2000/ 1000/ 500/1	-----	PS	2000/ 1000/ 500/V	10/ 5/ 2.5 Ohm	30/ 60/ 120

ISF for metering core should be less than 5. The rated extended primary current of the CTs shall be 120% continuous of 2000A. Physical arrangement of CTs shall be as per Protection SLD.



CLAUSE NO.

TECHNICAL REQUIREMENTS

CORE DETAILS OF 132kV VTs (GIS)					TABLE -XIII
Secondary Winding	Application	Rated Voltage (V)	Secondary Accuracy	Rated Burden (min) VA*	Secondary Burden (min) VA*
I	Protection	110/v3	3P	75 VA	
II	Protection	110/v3	3P	75 VA	
III	Metering	110/v3	0.2	75 VA	

The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 150 VA on all the three windings without any adjustments during operation.

* This is minimum burden specified, however bidder to consider VA burden to suit the requirement of the offered system. The supporting calculation to be furnished during detail engineering.

CORE DETAILS OF 132kV CVTs (AIS)					TABLE - XIV
Secondary Core	Application	Rated Voltage (V)	Secondary Accuracy	Output Burden - Minimum	
I	Protection	110/v3	3P	75 VA	
II	Protection	110/v3	3P	75 VA	
III	Metering	110/v3	0.2	75 VA	

The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 150 VA on all the three windings without any adjustments during operation.

CORE DETAILS OF 33kV CT							TABLE - XV	
CT No.	Core No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	1	Tie HV REF	1000/ 1	-----	PS	1000V	5	30
2	1	Tie LV REF	2000/ 1	-----	PS	2000V	10	30
	2	Tie BACKUP E/F	2000/ 1	15	5P20	-----	-----	-----

Note: The rated extended primary current of the CTs shall be 120% continuous of rated current.

6.00.00

SURGE ARRESTOR

6.01.00

GENERAL

6.01.01

The surge arrestors shall conform in general to IEC-60099-4 and IS: 3070 except to the extent modified in the specification.




CLAUSE NO.	TECHNICAL REQUIREMENTS
6.01.02	Arrestors shall be hermetically sealed units, self supporting construction, suitable for mounting on lattice/tubular type support structures.
6.02.00	DUTY REQUIREMENTS
6.02.01	The Surge Arresters (SAs) shall be capable of discharging over-voltages occurring due to switching of unloaded transformers, reactors and long lines.
6.02.02	The reference current of SAs shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
6.02.03	The SAs shall be capable of withstanding meteorological and short circuit forces under site conditions.
6.03.00	CONSTRUCTIONAL FEATURES (FOR AIS)
6.03.01	Each Surge Arrester (SA) shall be hermetically sealed single phase unit.
6.03.02	The non linear blocks shall be sintered metal oxide material. The SA construction shall be robust with excellent mechanical and electrical properties.
6.03.03	SAs shall have pressure relief devices and arc diverting ports suitable for preventing shattering of porcelain housing and to provide path for flow of rated fault currents in the event of SA failure.
6.03.04	The SA shall not fail due to porcelain contamination.
6.03.05	Seals shall be effectively maintained even when SA discharges rated lightning current.
6.03.06	Porcelain shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage upto maximum design value for SA. The cantilever strength of the insulator shall be minimum 500kg.
6.03.07	The end fittings shall be non-magnetic and of corrosion proof material. The metal flanges shall be fixed with the porcelain by cement or other materials so as to withstand the forces experienced in normal operation and provide continuous sealing for entry of moisture for a period of minimum 20 years.
6.04.00	CONSTRUCTIONAL FEATURES FOR GAS INSULATED SURGE ARRESTOR <ol style="list-style-type: none"> It will be SF6 gas insulated, metal enclosed surge arrester of the gapless non linear zinc oxide, heavy duty, station type. The arrester enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear and shall be fitted with a discharge counter located in an easily accessible position. The main grounding connection from the surge arrester to the earth shall be provided by the Contractor. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2
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CLAUSE NO.	TECHNICAL REQUIREMENTS
6.05.00	FITTINGS AND ACCESSORIES FOR AIS
6.05.01	Each SA shall be complete with insulating base for mounting on structure.
6.05.02	SAs shall be provided with grading and/or corona rings as required.
6.05.03	Self contained discharge counters, suitably enclosed for outdoor use (IP:55 degree of protection) and requiring no auxiliary or battery supply shall be fitted with each SA alongwith necessary connections to SA and earth. Suitable leakage current meters shall also be supplied in the same enclosure. The reading of milliammeter and counter shall be visible through an inspection glass panel to a man standing on ground. A pressure relief vent/suitable provision shall be made to prevent pressure build up.
6.06.00	PARAMETERS
6.06.01	General
a)	System neutral earthing Effectively earthed
b)	Installation Outdoor
c)	i) Nominal discharge current 20kA of 8/20 microsec. Wave (800kV & 400kV) 10 kA of 8/20 microsec. Wave (220 & 132kV)
	ii) Discharge current at which insulation coord. is done 20 kA of 8/20 microsec. wave
d)	Rated frequency 50 Hz
e)	Current for pressure relief test 50 kArms (765kV & 400kV), 40kArms (220kV), 31.5kArms (132kV),
f)	Prospective symmetrical fault current 50 kArms for 1 second (765kV & 400kV) 40 kArms for 1 second (220kV), 31.5 kArms for 1 second (132kV)
g)	Low current long duration test value (2000 micro sec.) As per IEC
h)	Pressure relief class Class A of Table VII of IS: 3070 or equivalent IEC
i)	Partial discharge at 1.05 MCOV (Continuous operating voltage) Not more than 50 p.C.
j)	Siesmic acceleration 0.3 g horizontal
k)	Reference ambient temp. 50 deg. C
l)	Minimum total creepage distance (mm) 28000/ 14700/ 8575/ 5075 for 765kV/ 400kV/ 220kV/ 132kV respectively.
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
6.06.02	765 kV class Surge Arrestor		
	a)	Rated system voltage	800 kV
	b)	Rated arrestor voltage	624 kV
	c)	Minimum discharge capability	13kJ/kV or corresponding to minimum discharge characteristics given in clause m) below whichever is higher.
	d)	Continuous operating voltage (COV) at 50 deg. C	490 kV rms
	e)	Min. Switching surge residual voltage at 1 kA	1180 kVp
	f)	Maximum residual voltage at	
) 20kA nominal discharge current	1480 kVp
	g)	Steep fronted wave residual voltage at 10kA	1480 kVp
	h)	High current short duration test value (4/10 microsec. wave)	100 kAp
	j)	Switching Impulse withstand voltage of arrestor housing	As per IEC
	k)	Impulse withstand voltage of arrestor Housing with 1.2/50 micro sec. wave.	As per IEC
	l)	RIV at 508 kV (rms)	Less than 2500 micro volts
	m)	Long duration discharge class	3
	n)	The surge arrestors are provided to protect the following equipment whose insulation levels are indicated in the table I given below. The contractor shall carry out the insulation coordination studies for deciding the location of the surge arrestors.	
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CLAUSE NO.

TECHNICAL REQUIREMENTS

TABLE – I

S.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL	
		LIGHTNING IMPULSE (kVp) FOR 765 KV SYSTEM	SWITCHING SURGE 250/2500 (kVp) FOR 765 kV SYSTEM
1.	Power Transformer	± 1950	± 1550
2.	Instrument Transformer	± 2100	± 1550
3.	Reactor	± 1950	± 1550
CB/Isolator	Phase to ground	± 2100	± 1550
	Across open contacts	± 2100 (± 455)	± 1175 (± 650)

- o) Surge arrestors shall be capable of discharge on severe re-energisation switching surges on 800KV, 350KM long line with Surge impedance of 270 ohms and capacitance of 13nf/Km and over voltage factor of 1.9p.u. Surge arrestor shall be capable of discharging energy equipment to class 5 of IEC for a 800 kV system on two successive operations followed immediately by 50 Hz energisation with a sequential voltage profile as specified below:

1000 kVp for 3 peaks
 910 kVp for 0.1 second
 885 kVp for 1 second
 866 kVp for 10 seconds


6.06.03 **400 kV class Surge Arrestor**

- | | | |
|----|---|---|
| a) | Rated system voltage | 420 kV |
| b) | Rated arrestor voltage | 336 kV |
| c) | Minimum discharge capability | 12kJ/kV or corresponding to minimum discharge characteristics given in clause m) below whichever is higher. |
| d) | Continuous operating voltage (COV) at 50 deg. C | 267 kV rms |
| e) | Min. Switching surge residual voltage at 2 kA | 670 kVp |
| f) | Max. Switching Surge | 650 kVp |




CLAUSE NO.	TECHNICAL REQUIREMENTS																																		
	<p>voltage at 500A</p> <p>g) Maximum residual voltage at</p> <p>i) 10kA nominal discharge current 800 kVp</p> <p>ii) 20kA nominal discharge current 850 kVp</p> <p>h) Steep fronted wave residual voltage at 10kA 925 kVp</p> <p>i) High current short duration test value (4/10 microsec. wave) 100 kAp</p> <p>j) One minute dry/wet power frequency withstand voltage of arrestor housing 630 kV (rms)</p> <p>k) Impulse withstand voltage of arrestor Housing with 1.2/50 micro sec. wave. 1425 kVp</p> <p>l) RIV at 266 kV (rms) Less than 1000 micro volts</p> <p>m) Long duration discharge class 4</p> <p>n) The surge arrestors are provided to protect the following equipment whose insulation levels are indicated in the table I given below. The contractor shall carry out the insulation coordination studies for deciding the location of the surge arrestors.</p> <p style="text-align: center;">TABLE – I</p> <table border="1"> <thead> <tr> <th>S.NO.</th><th>EQUIPMENT TO BE PROTECTED</th><th colspan="2">INSULATION LEVEL</th></tr> <tr> <th></th><th></th><th>LIGHTNING IMPULSE (kVp) FOR 400 KV SYSTEM</th><th>SWITCHING SURGE 250/2500 (kVp) FOR 400 kV SYSTEM</th></tr> </thead> <tbody> <tr> <td>1.</td><td>Power Transformer</td><td>± 1425</td><td>± 1175</td></tr> <tr> <td>2.</td><td>Instrument Transformer</td><td>± 1425</td><td>± 1050</td></tr> <tr> <td>3.</td><td>Reactor</td><td>± 1300</td><td>± 1050</td></tr> <tr> <td></td><td>CB/Isolator</td><td></td><td></td></tr> <tr> <td>-</td><td>Phase to ground</td><td>± 1425</td><td>± 1050</td></tr> <tr> <td>-</td><td>Across open contacts</td><td>± 1425 (± 240)</td><td>± 900 (± 340)</td></tr> </tbody> </table>			S.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL				LIGHTNING IMPULSE (kVp) FOR 400 KV SYSTEM	SWITCHING SURGE 250/2500 (kVp) FOR 400 kV SYSTEM	1.	Power Transformer	± 1425	± 1175	2.	Instrument Transformer	± 1425	± 1050	3.	Reactor	± 1300	± 1050		CB/Isolator			-	Phase to ground	± 1425	± 1050	-	Across open contacts	± 1425 (± 240)	± 900 (± 340)
S.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL																																	
		LIGHTNING IMPULSE (kVp) FOR 400 KV SYSTEM	SWITCHING SURGE 250/2500 (kVp) FOR 400 kV SYSTEM																																
1.	Power Transformer	± 1425	± 1175																																
2.	Instrument Transformer	± 1425	± 1050																																
3.	Reactor	± 1300	± 1050																																
	CB/Isolator																																		
-	Phase to ground	± 1425	± 1050																																
-	Across open contacts	± 1425 (± 240)	± 900 (± 340)																																
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>o) Surge arrestors shall be capable of discharge on severe re-energisation switching surges on a 400 kV line upto 450 km. length with surge impedance of 300 ohms and capacitance of 11.986 nF/km and over voltage factor of 2.3 p.u. Surge arrestor shall be capable of discharging energy equipment to class 4 of IEC for a 420 kV system on two successive operations followed immediately by 50 Hz energisation with a sequential voltage profile as specified below:</p> <p>650 kVp for 3 peaks 575 kVp for 0.1 second 550 kVp for 1 second 475 kVp for 10 seconds</p> <p>p) 400 kV line circuit breakers are equipped with closing resistor of 400 ohms with pre insertion time switching over voltage to 2.3 p.u.</p>			
6.06.04	220 kV CLASS SURGE ARRESTOR			
	a) Rated System voltage	245 kV		
	b) Rated arrestor voltage	216 kV (Not less than)		
	c) Nominal discharge current	10 kA of 8/20 micro sec.		
	d) Minimum discharge capability	5 kilo joule/kV (referred to rated arrestor voltage corresponding to minimum discharge characteristics)		
	e) Continuous operating voltage at 50 ⁰ C.	168 kV (rms)		
	f) Maximum switching surge residual voltage (1 kA)	500 kVp (Max)		
	g) Max. residual voltage at			
	i) 5 kA	560 kVp		
	ii) 10 kA	600 kVp		
	h) Max. steep current residual voltage at 10 kA	650 kVp		
	i) Long duration discharge class	3		
	j) Current for Pressure Relief test	40 kArms		
	k) High current short duration test value (4/10 micro sec.)	100 kAp		
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CLAUSE NO.	TECHNICAL REQUIREMENTS																							
	<div><div>l)</div><div>One minute power frequency withstand voltage of arrestor housing (dry and wet)</div></div> <div><div>m)</div><div>Impulse withstand voltage of arrestor housing with 1.2/50 micro sec. Wave</div></div> <div><div>n)</div><div>Radio interference voltage at 92kV</div></div> <div><div>o)</div><div>Partial discharge at 1.05 MCOV (continuous operating voltage)</div></div> <div><div>p)</div><div>Arrestor shall be capable of discharging energy equivalent to class-3 of IEC on two successive operations.</div></div> <div><div>The surge arrestors are being provided to protect the following equipment whose insulation levels are indicated in the Table – I given below:</div></div>	<div><div>460 kV (rms)</div></div> <div><div>1050 kV (Peak)</div></div> <div><div>Not more than 1000 micro volt</div></div> <div><div>Not more than 50 p.c.</div></div>																						
	<div>TABLE – I</div> <table><tr><th>SL.NO.</th><th>EQUIPMENT TO BE PROTECTED</th><th>INSULATION LEVEL</th></tr><tr><td></td><td></td><th>LIGHTNING IMPULSE (kVp) FOR 220 kV SYSTEM</th></tr><tr><td>1.</td><td>Power Transformer</td><td>± 950</td></tr><tr><td>2.</td><td>Instrument Trf.</td><td>± 1050</td></tr><tr><td>3.</td><td>CB/Isolator</td><td></td></tr><tr><td></td><td>Phase to ground</td><td>± 1050</td></tr><tr><td></td><td>Across open contacts</td><td>± 1200</td></tr></table>			SL.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL			LIGHTNING IMPULSE (kVp) FOR 220 kV SYSTEM	1.	Power Transformer	± 950	2.	Instrument Trf.	± 1050	3.	CB/Isolator			Phase to ground	± 1050		Across open contacts	± 1200
SL.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL																						
		LIGHTNING IMPULSE (kVp) FOR 220 kV SYSTEM																						
1.	Power Transformer	± 950																						
2.	Instrument Trf.	± 1050																						
3.	CB/Isolator																							
	Phase to ground	± 1050																						
	Across open contacts	± 1200																						
6.06.05	<div><div>132 kV class Surge Arrestor</div><div><div>a)</div><div>Rated system voltage</div></div><div><div>b)</div><div>Rated arrestor voltage</div></div><div><div>c)</div><div>Nominal discharge current</div></div><div><div>d</div><div>Minimum discharge capability</div></div></div>	<div><div>145 kV</div></div> <div><div>120 kV (Not less than)</div></div> <div><div>10 kA of 8/20 micro sec.</div></div> <div><div>5 kilo joule/kV (referred to rated arrestor voltage corresponding to minimum discharge characteristics)</div></div>																						
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	e) Continuous operating voltage at 50 ⁰ C.	102 kV (rms)	
	f) Max. Switching surge residual voltage (1 kA)	280 kVp(max)	
	g) Max. residual voltage at		
	i) 5 kA	310 kVp	
	ii) 10 kA	330 kVp	
	h) Max. steep current residual voltage at 10 kA	370 kVp	
	i) Long duration discharge class (2 successive shots)	3	
	j) Current for Pressure relief test	40kArms	
	k) High current short duration test value (4/10 micro sec.)	100 kAp	
	l) One minute power frequency withstand voltage of arrestor housing (dry and wet)	275 kV (rms)	
	m) Impulse withstand voltage of arrestor housing with 1.2/50 micro sec. Wave	650 kV (Peak)	
	n) Radio interference voltage at 92kV	Not more than 1000 micro volt	
	o) Partial discharge at 1.05 MCOV (continuous operating voltage)	Not more than 50 p.c.	
TABLE – I			
S.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL	
		LIGHTNING IMPULSE(kVp) FOR 132kV SYSTEM	
1.	Power Transformer	± 650	
2.	Instrument Transformer	± 650	
3.	CB/Isolator - Phase to ground	± 650	
-	Across open contacts	± 750	
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
6.07.00	TESTS			
6.07.01	Surge arrestor (GIS) shall be type tested in accordance with clause no. 1.06.02 & 1.06.03.			
6.07.02	Surge arrestors (AIS) shall confirm to all type tests (as applicable) as per IEC 60099-4 and shall be subjected to routine and acceptance tests in accordance with IEC-60099-4. The resistive current drawn by the arrestor for at rated voltage shall be indicated in the routine test report.			
7.00.00	POST INSULATOR			
7.01.00	GENERAL			
	The post insulators shall conform in general to latest IS: 2544 and IEC – 60815, 60168.			
7.02.00	CONSTRUCTIONAL FEATURES			
7.02.01	Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators shall be accepted. Height of post insulator shall be preferably as given under parameters of this part.			
7.02.02	The other requirements of insulator as given under auxiliary requirements shall also be applicable.			
7.03.00	TESTS			
7.03.01	In accordance with the stipulations elsewhere the post insulators shall conform to type tests and acceptance, sample and routine tests as per IS: 2544, IEC-60168 shall be carried out.			
7.03.02	In addition to acceptance/sample/routine tests as per IS: 2544, IEC-60168, the following tests shall also be carried out.			
	a) Ultrasonic tests on all cut shells as routine check.			
	b) Visual examination and magna flux test on all flanges prior to fixing.			
	c) Check for uniformity of thickness and weight of zinc coating as a sample test from each lot of flanges prior to fixing.			
	d) Bending load test shall be carried out at 50% minimum failing load in four directions as a routine test.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
7.03.03	e)	Bending load in four directions at 100% minimum bending load guaranteed on samples as per clause-2.3 of IEC. Subsequently this post insulator shall not be used.		
	f)	Tests for deflection measurement at 20, 50, 70% of specified minimum failing load on sample.		
	The post insulator shall conform to following type tests as applicable according to voltage class:			
	a)	Switching Impulse withstand test (dry & wet)		
	b)	Lightning Impulse withstand test (dry)		
	c)	Power frequency withstand test (dry & wet)		
	d)	Measurement of RIV		
	e)	Corona extinction voltage test		
	f)	Test for deflection under load.		
	g)	Test for mechanical strength,		
7.04.00	PARAMETERS			
7.04.01	765 kV class Bus Post Insulator			
a)	Type	Solid core type		
b)	Voltage class (kV)	800		
c)	Dry and wet one minute power frequency withstand voltage (kV)	830		
d)	Dry impulse withstand positive and negative (kVp)	+/- 2100		
e)	Wet switching surge withstand voltage (kVp)	+/- 1550		
f)	Max. radio interference voltage (in micro Volts) for any frequency between 0.5 MHz to 2 MHz at voltage of 508 kV (rms) between phase to ground.	2500		
g)	Corona extinction voltage (kV rms)	508		
h)	Total min. cantilever strength (Kg)	800		
i)	Min. torsional moment (Kg m)	As per IEC 60273		
j)	Minimum total creepage distance (mm)	28000		
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<p>k) i) Top p.c.d. (mm) 225 ii) Bottom p.c.d. (mm) 325</p> <p>l) No. of bolts : Top 4 : Bottom 8</p> <p>m) Diameter of bolt holes (mm) : Top M16 : Bottom M18</p> <p>Note: If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the bidder without any price implication.</p> <p>n) pollution level as per IEC-815 Class III, Heavy</p>		
	<p>7.04.02. 400 kV class Bus Post Insulators</p> <p>a) Type Solid core type</p> <p>b) Voltage class (kV) 400</p> <p>c) Dry and wet one minute power frequency withstand voltage (kV) 680</p> <p>d) Dry impulse withstand positive and negative (kVp) 1550</p> <p>e) Wet switching surge withstand voltage (kVp) 1175 (As per IEC)</p> <p>f) Total min. cantilever strength (Kg) 800</p> <p>g) Min. torsional moment (Kg m) 600</p> <p>h) Total height of insulator (mm) 3650 i) Top p.c.d. (mm) 127 ii) Bottom p.c.d. (mm) 300</p> <p>i) No. of bolts : Top 4 : Bottom 8</p> <p>j) Diameter of bolt holes (mm) : Top M16 : Bottom dia 18</p> <p>h) Minimum total creepage distance (mm) 14700</p> <p>i) pollution level as per IEC-815 Class III, Heavy</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 77 OF 97



CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Note: If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the bidder without any price implication.			
7.04.03.	220 kV BUS POST INSULATOR			
a)	Type	Solid core		
b)	Voltage class (kV)	245		
c)	Dry and wet one minute power frequency withstand voltage (kV)	460		
d)	Dry impulse withstand positive and negative (kVp)	1050		
e)	Max. radio interference voltage (Microvolts) for any frequency between 0.5 MHz to 2 MHz at voltage of 92 kV (rms) between phase to ground	1000		
f)	Total min. cantilever strength (Kg)	800		
g)	Min. torsional moment (Kg m)	As per IEC		
h)	Total height of insulator (mm)	2300		
i)	i) Top p.c.d. (mm)	127		
	ii) Bottom p.c.d. (mm)	254		
j)	No. of bolts : Top :	4		
	Bottom :	8		
k)	Diameter of bolt holes (mm)			
	Top :	M16		
	Bottom :	dia 18		
l)	pollution level as per IEC-815	Class III, Heavy		
m)	Minimum total creepage distance (mm))	8575		
7.04.04	132 kV class Bus Post Insulators			
a)	Type	Solid core		
b)	Voltage class (kV)	145		
c)	Dry and wet one minute power frequency withstand voltage (kV)	275		
d)	Dry impulse withstand positive and negative (kVp)	650		
e)	Max. radio interference voltage	1000		
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	<p>(Microvolts) for any frequency between 0.5 MHz to 2 MHz at voltage of 92 kV (rms) between phase to ground</p> <p>f) Total min. cantilever strength (Kg) 600</p> <p>g) Min. torsional moment (Kg m) 500</p> <p>h) Total height of insulator (mm) 1500</p> <p>i) i) Top p.c.d. (mm) 127 ii) Bottom p.c.d. (mm) 225</p> <p>j) Diameter and no. of bolt holes (mm)</p> <p>Top : M16 x 4 Bottom : dia 18 x 4</p> <p>k) Pollution level as per IEC-815 Class III, Heavy</p> <p>l) Minimum total creepage distance (mm) 5075</p>		
	<p>7.04.05. 33kV BUS POST INSULATOR</p> <p>a) Type : Solid core</p> <p>b) Voltage class (kV) : 36</p> <p>c) Rated Insulation levels</p> <p>i. Rated one minute power frequency withstand voltage : 70kV (rms)</p> <p>ii. Rated lightning impulse withstand voltage : 170kV (Peak)</p> <p>d) Total min. cantilever strength (kg) : As per IEC 60273</p> <p>e) Min. torsional moment (Nm) : As per IEC 60273</p> <p>f) Minimum total creepage distance (mm) : 1260</p> <p>g) i) Top p.c.d. (mm) : 76 ii) Bottom p.c.d. (mm) : 76</p> <p>h) No. of bolts : Top : 4 Bottom : 4</p> <p>i) Diameter of bolt holes (mm)</p> <p>Top : M12</p>		
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I)	<div>Bottom : M12</div> <div>Pollution level as per IEC-815 : Class-III- Heavy</div>
8.00.00	WAVE TRAP
8.01.00	GENERAL
	The Wave Trap covered under the package shall conform to IEC 353 or IS: 8792, IS: 8793 and relevant IEC/IS Specifications except to the extent modified by the specification.
8.02.00	LOCATION OF EQUIPMENT
8.02.01	Wave Traps as specified under this section shall be installed at the respective transmission line bays as indicated in single line diagram. The foundation shall be provided for all the three phases. The wave traps shall be installed in two phases in such a way that it should match with the location of wave traps on the phases of other side of the transmission line.
8.03.00	TECHNICAL REQUIREMENTS
8.03.01	Wave Trap shall be inserted into high voltage transmission line to prevent undue loss of carrier signal for all power system conditions. Its impedance shall be negligible at power frequency (50 Hz) so as not to disturb power transmission but shall be relatively high over the frequency band appropriate to carrier transmission.
8.03.02	Wave trap shall consist of a main coil designed to carry continuously the rated current without exceeding the limit of temperature rise. It shall be supplemented with a protective device and tuning device.
8.03.03	Wave trap shall be Broad Band tuned for its entire carrier frequency range. Resistive component of impedance of the Wave trap within its carrier frequency blocking range shall not be less than 570 ohms.
8.03.04	Wave trap shall be provided with a protective device in the form of lightning arrestor which shall be designed and arranged such that neither significant alternation in its protective function nor physical damage shall result from either temperature rise or the magnetic field of the main coil at continuous rated current or rated short time current. The protective device shall neither enter into operation nor remain in operation, following transient actuation by the power frequency voltage developed across the line trap by the rated short time current. The protective device shall be shunt connected to the main coil and tuning device.
	The lightning arrestor provided shall have a rated discharge current of 10 kA. Coordination, however, shall be done by taking 20 kA discharge current into account.
8.03.05	The lightning arrestor provided with the Wave trap of each rating shall fully comply with the requirements of IS-3070-Part-I (1974)/IEC-60099.
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
8.03.06	The lightning arrester provided with the Wave trap shall be subject to routine and acceptance tests as per IEC – 60099.			
8.03.07	The Wave trap on 765kV & 400 kV lines shall show no visual corona at extinction voltage of 508kVrms & 320 kV rms respectively. Suitable corona rings shall be incorporated in the line trap for 765kV & 400 kV.			
8.03.08	Wave trap shall be equipped with bird barriers.			
8.03.09	Wave trap shall preferably be spray painted with light admiralty Grey paint (shade 697 of IS-5) or may have its natural epoxy colour.			
8.03.10	Wave trap shall conform to IEC - 60353 fulfilling the following technical particulars.			
	765 KV		400kV	
a) Rated Power frequency	50 Hz		50 Hz	
b) Rated system voltage	765 KV		400kV	
c) Highest system voltage	800kV		420kV	
d) Rated continuous current at 50degree C ambient	As per SLD		As per SLD	
g) Rated short time current for 1 sec.	50kA		50kA	
f) Nominal discharge current of protective device	20kA		10 kA	
g) Type of tuning	Broad Band		Broad Band	
h) Rated Blocking band-width	50 - 500 KHZ for 1 mH 90 - 500 KHZ for 0.5 mH		50 - 500 KHZ for 1 mH 90 - 500 KHZ for 0.5 mH	
i) Inductance	1.0 mH / 0.5 mH		1.0 mH / 0.5 mH	
j) Radio Interference voltage level	not more than 2500 micro volts at 508 kV		not more than 500 micro volts at 266kV	
	<u>220kV</u>			
a) Rated power frequency	50 Hz			
b) Rated system voltage	220kV			
c) Highest system voltage	245kV			
d) Rated continuous current at 50degreeC ambient	1600Amps			
e) Rated short time current for 1sec.	40kA			
f) Nominal discharge current of protective device	10kA			
g) Type of tuning	Broad Band			
h) Rated Blocking band-width	50-500 KHZ for 1.0 mH 90-500 KHZ for 0.5 mH			
i) Inductance	1.0mH / 0.5 mH			
j) Radio Inteference voltage level for 0.5 MHz to 2.0 MHz	not more than 500 micro volts at 156 kV			
8.03.11	In accordance with the requirements stipulated elsewhere, the Wave Trap shall confirm to following type tests and shall be subjected to routine and acceptance tests as per IEC-60353.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS
	a) Measurement of inductance of the main coil b) Measurement of temperature rise c) Insulation tests d) Short time current tests e) Corona Extinction Voltage Measurement f) Radio Interference Voltage measurement
8.04.00	WAVE TRAP MOUNTING
8.04.01	The Wave Traps shall be suitable for outdoor pedestal mounting and shall be mechanically strong enough to withstand the stresses due to maximum wind pressure of 195 kg/square metre.
8.04.02	For pedestal mounting, each Wave trap shall be mounted on a lattice structure formed by three solid core type insulators.
9.00.00	REQUIREMENT OF AUXILIARY ITEMS
9.01.00	ALUMINIUM TUBULAR CONDUCTOR
9.01.01	The aluminium tube shall be grade 63401 WP (range2) as per IS 5082.
9.01.02	There shall be no negative tolerance on OD and thickness of the tube. Other tolerances shall be as per IS:2678 and 2673.
9.01.03	Tests: In accordance with stipulations of specification routine tests shall be conducted on tubular conductor as per IS:5082. Also the wall thickness and ovality shall be measured by ultrasonic method. In addition 0.2% proof tests on both parent material and aluminium tube after welding shall be conducted.
	For 765kV a) Size 4.5" IPS (EH type), b) Outer diameter 120.00 mm with no negative tolerance c) Thickness of tube 12.00 mm with no negative tolerance d) Cross-sectional area 4071.5 sq. mm. e) Weight 11.034 kg/m f) Aluminum grade 63401 WP (range 2) conforming to IS: 5082
	For 400/ 220kV a) Size 4" IPS (EH type), b) Outer diameter 114.20 mm with no negative tolerance c) Thickness of tube 8.51 mm with no negative tolerance d) Cross-sectional area 2825.61 sq. mm. e) Weight 7.7 kg/m f) Aluminum grade 63401 WP (range 2) conforming to IS: 5082.
	For 132kV a) Size 3" IPS (EH type), b) Outer diameter 88.9 mm with no negative tolerance c) Thickness of tube 7.62 mm with no negative tolerance
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CLAUSE NO.	TECHNICAL REQUIREMENTS
d) Cross-sectional area e) Aluminum grade	1947 sq. mm. 63401 WP (range 2) conforming to IS: 5082.
9.02.00 a) Code and standard b) Name c) Overall diameter d) Weight e) Ultimate tensile strength f) Strands and wire diameter of - Aluminium	AAC Bull CONDUCTOR for 765kV IS 398 AAC Bull 38.25 mm 2.4 kg/m 139.0 kN minimum 61/4.25 mm ACSR CONDUCTOR for 400kV/ 220kV/ 132kV IS 398 MOOSE ACSR 31.77 mm 2.004 kg/m 161.2 kN minimum Strands and wire diameter of - Aluminium 54 / 3.53 mm - Steel 7 / 3.53 mm
9.03.00	CLAMPS AND CONNECTORS
9.03.01	The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS: 617 for connecting to equipment terminals and conductors of aluminium. In case equipment terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetal.
9.03.02	The material of clamps and connectors shall be Galvanised mild steel for connecting to G.S.shield wire.
9.03.03	Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.
9.03.04	All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.
9.03.05	They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.
9.03.06	Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.
9.03.07	Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last atleast till erection time.
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<p>9.04.00</p> <p>9.04.01</p> <p>9.04.02</p> <p>9.04.03</p> <p>9.04.04</p>	<p>INSULATOR STRING HARDWARE</p> <p>The insulator hardware shall be of bolted type and shall be of forged steel except for insulator cap, which can be of malleable cast iron. It shall also generally meet the requirements of clamps and connectors as specified above.</p> <p>In one span, Tension string assembly at one end shall be supplied with suitable turn buckle.</p> <p>Disc Insulator for porcelain type insulator The disc insulator shall meet the following parameters:</p> <p>a. Type : Antifog type insulator b. Size of insulator : 255x145 c. Electro mechanical strength : 120kN d. Leakage distance (mm) : 430mm minimum or as required to meet the total creepage. e. Power frequency withstand voltage : 85 kV (dry), 50kV (wet)</p> <p>Insulator string</p> <p>The insulator string shall meet the following parameters</p> <p>765kV</p> <p>a) Type Porcelain type/ composite type b) Creepage distance 28000mm c) PF withstand voltage 830 KV 1 min(rms) (dry and wet) d) L / I withstand voltage +/- 2100 KV e) S / I Withstand voltage +/- 1550 KV f) Pollution level(as per IEC 71) Class-III, Heavy g) No. of disc insulator (for porcelain) min 66 nos. h) Electro mechanical strength 210 kN/ String</p> <p>400 KV</p> <p>Type Porcelain type/composite type a) Creepage distance 14700 mm 10500 mm as per amendment 3 b) PF withstand voltage 680 KV 1 min(rms) (dry and wet) c) L / I withstand voltage +/- 1550 KV d) S / I Withstand voltage +/- 1050 KV e) No. of disc insulator (for porcelain) 35 25 Nos as per amendment 3 f) Electro mechanical strength 120 KN / string</p> <p>220 KV</p> <p>a) Type Porcelain type b) Creepage distance 8575 mm c) PF withstand voltage 460 KV (rms) 1 min (dry and wet) d) L / I withstand voltage +/- 1050 KV e) S / I Withstand voltage ----- f) No. of disc insulator (for porcelain) 20 nos.</p>
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	<div><div>g) Electro mechanical strength120 KN/ String</div><div>132kV</div><div>a) TypePorcelain type/ composite type</div><div>i) Creepage distance5075 mm</div><div>j) PF withstand voltage275kV 1 min(rms) (dry and wet)</div><div>k) L / I withstand voltage+/- 650 KV</div><div>l) S / I Withstand voltage.....</div><div>m) Pollution level(as per IEC 71)Class-III, Heavy</div><div>n) No. of disc insulator (for porcelain)12 nos.</div><div>o) Electro mechanical strength120kN/string</div></div>				
	TECHNICAL PARAMETERS FOR SF6/ AIR BUSHING				
		<u>765kV</u>	<u>400kV</u>	<u>220kV</u>	<u>132kV</u>
a)	Rated Voltage (kVrms)	800kVrms	420kVrms	245kVrms	145kVrms
b)	Rated Current (Amp)As per SLD.....			
c)	1.2/ 50 micro second Impulse voltage (L/I Withstand voltage)	± 2100kVp	± 1425kVp	±1050kVp	± 630kVp
d)	250/2500 micro second switching Impulse voltage	± 1550kVp	± 1050kVp	-----	-----
e)	One minute power Frequency withstand voltage	960kVrms	650kVrms	460kVrms	275kVrms
f)	Minimum total Creepage Distance (mm)	28000	14700	8575	5075
g)	Minimum Cantilever Strength (kN)	10	10	8	5
9.05.00	SPACERS				
9.05.01	Spacers shall conform to IS: 10162. They shall be of non-magnetic material except nuts and bolts, which shall be of hot dip galvanised mild steel.				
9.05.02	Spacers shall generally meet the requirements of clamps and connectors as specified above. Its design shall take care of fixing and removing during installation and maintenance.				
9.05.03	In addition to the type tests as per IS: 10162, clamp slip test should have been conducted. In this test the sample shall be installed on test span of twin/quad bundle string at a tension of 44.2 kN (4500 kg). One of the clamps when subjected to a longitudinal pull of 2.5 kN (250 kg) parallel to the axis of conductor shall not slip, i.e. permanent displacement between conductor and clamp after the test shall not exceed 1.0 mm. This test should have been performed on all other clamps of the sample.				
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CLAUSE NO.	TECHNICAL REQUIREMENTS
9.06.00	<p>EARTHING CONDUCTOR</p> <p>a) The main conductor buried in earth shall be 40mm dia rod for main and auxiliary mat. The earthing conductors over the ground shall be of 75x12 mm GS flat. The earthing leads for columns and auxiliary structures, cable trenches shall be of 75x12 mm GS flat. The earthing of the lighting fixtures shall be carried out by 16 SWG wire.</p> <p>b) All earthing conductors above the ground level shall be galvanised steel only.</p>
9.07.00	<p>Earthwire for Lightning Protection</p> <p>a) Number of strands 7 of steel</p> <p>b) Strand diameter 3.66 mm</p> <p>c) Overall diameter 10.98 mm</p> <p>d) Weight 583 kg/km approx.</p> <p>e) Ultimate tensile strength 68.4 kN minimum</p> <p>f) Total cross-sectional area 73.65 sq.mm.</p> <p>g) Calculated d.c. resistance 2.5 ohms/km at 20 deg.C.</p> <p>h) Direction of lay of outer layer Right hand</p> <p>i) Protective coating for storage Boiled linseed oil to avoid wet storage stains (white rust)</p> <p>The earth wire shall be preformed and post formed quality.</p>
9.08.00	<p>BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS, AND DISC INSULATORS</p>
9.08.01	<p>Bushings shall be manufactured and tested in accordance with IS:2099 & IEC:60137 while hollow column insulators shall be manufactured and tested in accordance with IEC 62155/IS 5284. The support insulators shall be manufactured and tested as per IS:2544 / IEC 60168/IEC 60273. The insulators shall also conform to IEC 60815 as applicable having alternate long and short sheds.</p> <p>Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.</p>
9.08.02	<p>Porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.</p>
9.08.03	<p>Glazing of the porcelain shall be uniform brown in colour, free from blisters, burns and other similar defects.</p>
9.08.04	<p>The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall be lead to deterioration. All ferrous parts shall be hot dip galvanised.</p>
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9.08.05	Post type insulators shall consist of a porcelain part permanently secured in metal base to be mounted on supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand all shocks to which they may be subjected to during operation of the associated equipment.		
9.08.06	Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.		
9.08.07	All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued, porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints.		
9.08.08	In accordance with the requirements stipulated elsewhere, bushings, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests and acceptance test/ sample test in accordance with relevant standards.		
9.09.00	CABINETS, BOXES, KIOSKS, PANELS, ETC.		
9.09.01	All types of control cabinets, junction boxes, marshaling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC: 60439 as applicable.		
9.09.02	They shall be of Stainless steel or Aluminium. The thickness of Stainless steel shall be minimum 1 mm. The thickness of aluminium shall be minimum 3 mm and shall provide rigidity. Top of the boxes shall be sloped towards the rear of the box.		
9.10.00	BAY MARSHALLING BOX		
9.10.01	Bay Marshaling Box located at a convenient location to receive and distribute cables shall be provided as required. It shall meet all the requirements as specified for cabinets/boxes.		
9.10.02	It shall have three separate distinct compartments for following purposes: - To receive two incoming 415V, three phase, AC supplies controlled by 100A four pole MCBs with auto changeover provision, and to distribute five (5) three phase ac supplies controlled by 32A four pole MCBs. It shall also be provided with 63A, 3 phase 4 pin industrial grade receptacle with rotary switch. - To receive three phase incoming from first compartment and to distribute ten (10) single phase ac supplies controlled by 16A two pole MCBs. - 150 nos. terminal blocks in vertical formation for interlocking facility.		
9.11.00	AUXILIARY SWITCH The auxiliary switch shall conform of following type tests:		
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	<p>a) Electrical endurance test - A minimum of 1000 operations for 2A. D.C. with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/ visual defects/ temperature rise test.</p> <p>b) Mechanical endurance test - A minimum of 5000 operations with a subsequent checking of contact pressure test/ visual examination</p> <p>c) Heat run test on contacts</p> <p>d) IR/HV test, etc.</p>
9.12.00	<p>Type tests All equipment with their terminal connectors, control cabinets, main protective relays, etc. as well as insulators, insulator strings with hardwares, clamps and connectors, marshalling boxes, etc., shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections.</p>
10.00.00	INSTALLATION
10.01.00	EARTHING
	<p>The earthing shall be done in accordance with requirements given in Annexure-II of this section and drawing enclosed with the specifications. Earthing of panels shall be done in line with the requirements given in respective equipment section of this specification.</p>
10.02.00	CIVIL WORKS
	<p>The civil works shall be done in accordance with requirements stipulated elsewhere in the specification.</p>
10.03.00	STRUCTURAL STEEL WORKS
	<p>The structural steel works shall be done in accordance with requirements stipulated elsewhere in the specification.</p>
10.04.00	BAY EQUIPMENT
10.04.01	<p>The disposition of equipment to be supplied are shown in enclosed tender drawings.</p>
10.04.02	<p>The Contractor shall prepare layout drawings and submit the same for approval of the Employer. The approval of drg. shall not absolve Contractor from his responsibility regarding designing & engineering of switchyard and Contractor shall be fully responsible for all works covered in the scope of this specification.</p>
10.05.00	LIGHTNING PROTECTION
10.05.01	<p>Direct stroke lightning protection (DSLPP) shall be provided in the switchyard by lightning masts (at least 50 m high) and shield wires.</p>
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10.05.02	Lightning protection System down conductors shall not be connected to other conductors above ground level. Also no intermediate earthing connection shall be made to Surge arrester, Voltage Transformer, earthing leads for which shall be directly connected to rod electrode.		
10.05.03	Every down conductor shall be provided with a test joint at about 150mm above ground level. The test joint shall be directly connected to the earthing system.		
10.05.04	The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.		
10.06.00	EQUIPMENT ERECTION NOTES		
a)	All support insulators, circuit breaker interrupters and other fragile equipment shall be handled with cranes with suitable booms and handling capacity.		
b)	Where, assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense. The contractor shall strictly follow manufacturer's recommendations for handling and erection of equipment.		
c)	The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc. Handling equipment, sling ropes etc. should be tested before erection and periodically thereafter for strength.		
d)	Bending of piping should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced. The pipes shall be thoroughly cleaned before installation.		
e)	Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.		
f)	For cleaning the inside and outside of hollow insulators only Muslin or leather cloth shall be used.		
10.07.00	CABLING		
10.07.01	Cabling shall be on cable racks, in trenches, vertical shafts, excavated trenches for direct burial, pulled through pipes and conduits run clamped on steel structures etc. in accordance with the requirements specified elsewhere in the specification.		
10.07.02	Cables inside the switchyard shall be laid on bolted GI angle supports at 600mm spacing with separate tiers for control and power cables. The GI angles shall be bolted / welded to galvanized insert plates inside RCC trenches.		
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10.07.03	Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the ground. In the case of equipment located away from cable trench either pipe inserts shall be embedded in the ground connecting the cable trench and the equipment or in case the distance is small, notch/opening shall be provided. In all these cases necessary bending radii as recommended by the cable supplier shall be maintained.			
10.07.04	Cabling in the control room shall be done on ladder type cable trays with supports at an interval of 2000mm.			
10.07.05	All interpole cables (both power & control circuit) for equipments shall be laid in cable trenches/G.I. Conduit Pipe of NB 50/100mm which shall be burried in the ground at a depth of 300mm.			
a)	<div>ANNEXURE-II</div> <div>EARTHING NOTES FOR SWITCHYARD</div> <div>GENERAL</div> <div>i) Earthing of operating boxes, cubicles shall be done by 50 X 6 mm GS flat while cable trenches and structure by 75 X 12 mm GS flat.</div> <div>ii. Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.</div> <div>iii. Earthing system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.</div>			
b)	<div>EARTHING OF GIS</div> <div>i) The grounding system shall be designed and provided as per IEEE-80-2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-mechanical interferences.</div> <div>ii.) The GIS contractor shall define clearly what constitutes the main grounding bus of the GIS. The GIS contractor must supply, commission the entire grounding work of GIS viz conductor, clamps, joints, bimetallic strips (for connection between different type of earthing materials), operating and safety platforms etc.</div> <div>iii.) The enclosure of the GIS shall be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, transformer terminals, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected with links or straps to bridge the flanges. Subassembly-to-subassembly bonding shall be provided to provide gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.</div>			
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iv)	The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise is kept to an acceptable level. Each marshalling box, local control panel, power and control cable sheaths and other non current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.			
	u) The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrester, phase/earth fault and discharges between contracts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The contractor shall provide suitable barrier of non-linear resistor/counter discontinued SF6/Transformer and SF6/ HV cable bushing etc. to mitigate transient enclosure voltage.			
c)	DETAILS OF EARTHING SYSTEM			
	Item	Size	Material	
	Main Earthing conductor	40mm dia rod	Mild steel	
	Conductor above ground & earthing leads (for equipment)	75 x 12/ G.S. Flat 50 x 6	Galvanized steel	
	Rod Electrode	40mm dia, 3000mm	Mild steel	
	G.I. Earthwire	7/8 SWG	GI	
	Copper Flat (if required)	as per requirement		
d)	For Step and Touch Potential the following parameters shall be considered			
	i) Current distribution factor – 1 (one)			
	ii) Duration of fault current – 0.5 sec			
	iii) Human body weight – 50kg			
e)	Grid resistance shall be less than 1(one) ohm.			
f)	EARTHING CONDUCTOR LAYOUT			
	i.	Earthing conductors in outdoor areas shall be burried atleast 600mm below finished grade level unless stated otherwise.		
	ii.	Minimum 6000mm or higher spacing between rod electrodes shall be provided based on the earthmat design calculations.		
	iii.	Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid atleast 300mm below them and shall be re-routed in case it fouls with equipment/structure foundations.		
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iv.	Tap connections from the earthing grid to the equipment/structure to be earthed, shall be terminated on the earthing terminals of the equipment/structure, if the equipment is available at the time of laying the grid. Otherwise, “earth insert” with temporary wooden cover or “earth riser” shall be provided near the equipment foundation/pedestal for future connections to the equipment earthing terminals.		
v.	Earthing conductor along their run on cable trench ladder columns, beams, walls, etc. shall be supported by suitable welding/cleating at intervals of 750mm. Earthing conductors along cable trenches shall be on the wall nearer to the equipment. Wherever it passes through walls, floors etc. galvanized iron sleeves shall be provided for the passage of the conductor. Both ends of the sleeves shall be sealed to prevent the passage of water through the sleeves.		
vi.	Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.		
vii.	In outdoor areas, tap connections shall be brought 300mm above ground level for making connections in future, in case equipment is not available at the time of grid installations.		
viii.	Earthing conductors crossing the road shall be either installed in hume pipes or laid at greater depth to suit the site conditions.		
ix.	Earthing conductors embedded in the concrete fibre shall have approximately 50mm concrete cover.		
g)	EQUIPMENT AND STRUCTURE EARTHING		
i.	The connection between earthing pads and the earthing grid shall be made by short and direct earthing leads free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with engineer.		
ii.	Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.		
iii.	Metallic conduits shall not be used as earth continuity conductor.		
iv.	A separate earthing conductor shall be provided for earthing lighting fixtures, lighting poles, receptacles, switches, junction boxes, lighting conduits, etc.		
v.	Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam, conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.		
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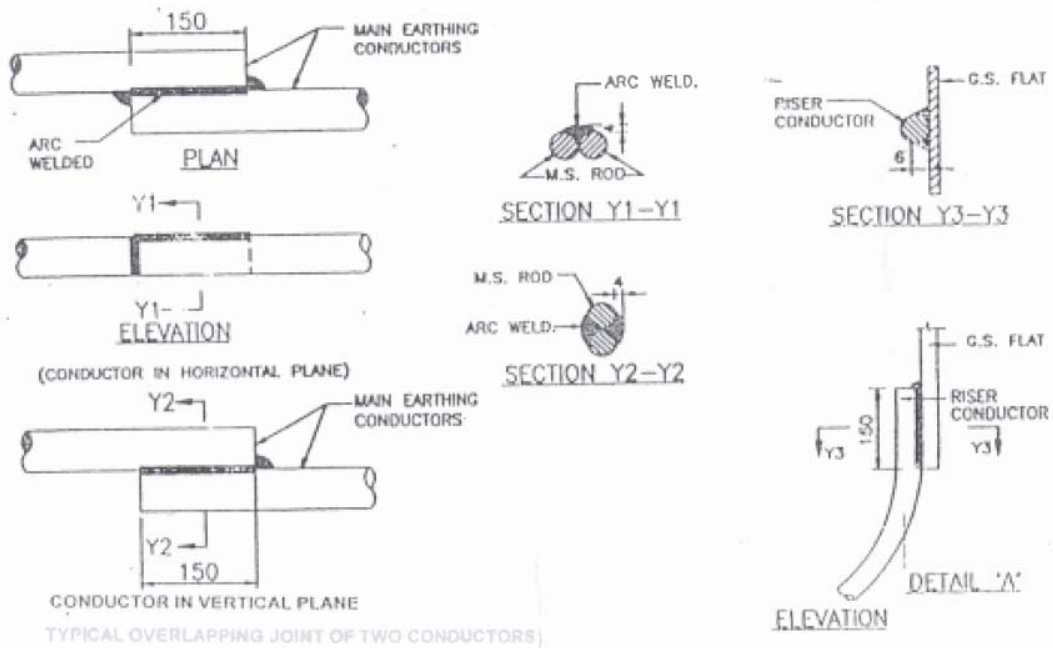
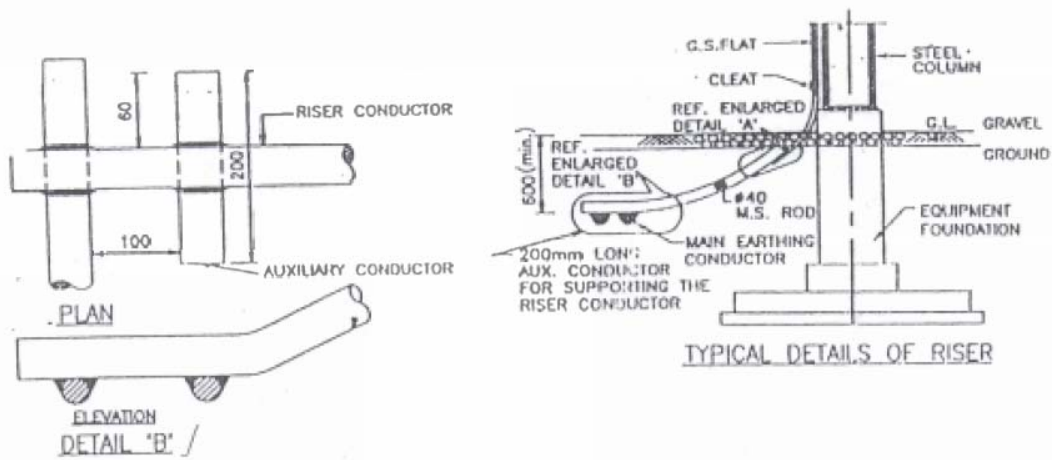
CLAUSE NO.	TECHNICAL REQUIREMENTS			
h)	vi.	Cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running alongwith the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points, whether specifically shown or not.		
	vii.	Railway tracks within switchyard area shall be bonded across fish plates and connected to earthing grid at several locations.		
	viii.	Earthing conductor shall be buried 2000mm outside the switchyard fence. Every post of the fence and gates shall be connected to earthing loop by one lead.		
	ix.	Flexible earthing connectors shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.		
	x.	Equipment earthing (Riser & welding of two conductors) shall be done as per standard drawing enclosed in this part.		
	JOINTING			
	i.	Earthing connections with equipment earthing pads shall be of bolted type. Contact surfaces shall be free from scales, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti-corrosive paint/compound.		
	ii.	Connection between equipment earthing lead and between main earthing conductors shall be welded/brazed type. For rust protections, the welds should be treated with red lead and afterwards thickly coated with bitumen compound to prevent corrosion.		
	iii.	Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.		
	iv.	Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.		
	v.	All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.		
	vi.	Bending of large diameter rod/thick conductor shall be done preferably by gas heating.		
	vii.	All arc welding with large diameter conductors shall be done with low hydrogen content electrodes.		
	i)	POWER CABLE EARTHING		
	Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.			
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j)	SPECIFIC REQUIREMENT FOR EARTHING SYSTEMS			
i.	Earthing terminal of each surge arrester, capacitor voltage transformer and lightning down conductors shall be directly connected to rod electrode which in turn, shall be connected to station earthing grid.			
ii.	Auxilliary earthing mat of 1500mm X 1500mm size comprising of closely spaced conductors at (300mm x 300mm) spacing and at 300mm below ground shall be provided below the operating handles of the isolators. Operating handle shall be directly connected to earthing mat.			
k)	SPECIFIC REQUIREMENTS FOR LIGHTNING PROTECTION SYSTEM			
i.	Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.			
ii.	Down conductors shall be cleated on the structures at 2000mm interval.			
iii.	Connection between each down conductor and rod electrodes shall be made via test joint located approximately 150mm above ground level.			
iv.	Lightning conductors shall not pass through or run inside G.I. conduits.			
v.	Lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.			
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NOTE : WELDING OF EARTHING CONDUCTOR SHALL BE CONDUCTED IN VERTICAL PLANE
WHEREVER POSSIBLE

EQUIPMENT EARTHING DETAILS

STANDARD DRAWING



CLAUSE NO.	TECHNICAL REQUIREMENTS			
11.00.00	SITE TESTING AND COMMISSIONING			
11.01.00	INTRODUCTION			
	An indicative list of tests for AIS and GIS as applicable is given below. Contractor shall perform any additional test based on specialties of the items as per the field QP/ instructions of the equipment supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall get the list of instruments approved from the Employer.			
11.02.00	GENERAL CHECKS			
	<div>a) Check for physical damage.</div> <div>b) Visual examination of zinc coating/ plating</div> <div>c) Check from name plate that all items are as per older/ specification.</div> <div>d) Check tightness of all bolts, clamps and connecting terminals using toque wrenches.</div> <div>e) For oil filled equipment check for oil leakage, if any. Also check oil level and top up.</div> <div>f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces.</div> <div>g) Check cleanliness of insulator and bushings.</div> <div>h) All checks and tests specified by the manufactures in their drawings and manuals as well as all tests specified in the relevant code of erection.</div> <div>i) Check for surface finish of grading rings (corona control ring.)</div> <div>j) Pressure test on all pneumatic lines at 1.5 times the rated pressure shall be conducted.</div>			
11.03.00	CIRCUIT BREAKERS			
	<div>a) Insulation resistance of each pole.</div> <div>b) Check adjustments, if any, suggested by manufacturer.</div> <div>c) Breaker closing and tripping time.</div> <div>d) Slow and power closing operation and opening</div> <div>e) Trip free and anti pumping operation.</div> <div>f) Minimum pick up volts of coils</div> <div>g) Contact resistance</div> <div>h) Functional checking of compressed air plant and all accessories</div> <div>i) Functional checking of control circuits, interlocks, tripping through protective relays and auto-reclose operation.</div> <div>j) Insulation resistance of control circuits, motor etc.</div> <div>k) Resistance of closing and tripping coils.</div>			
11.04.00	ISOLATORS			
	<div>a) Insulation resistance of each pole</div> <div>b) Manual and electrical operation on interlocks</div> <div>c) Insulation resistance of control circuits and motors.</div> <div>d) Ground connections</div> <div>e) Contact resistance</div> <div>f) Proper alignment to minimise the vibration to the extreme possible during operation.</div> <div>g) Measurement of operating torque for isolator and Earth switch</div> <div>h) Resistance of operating and interlocking coils.</div>			
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11.05.00	CURRENT TRANSFORMERS a) Insulation Resistance Test b) Polarity test. c) Ratio identification test-checking of all ratios on all cores by primary injection of current. d) Dielectric test of oil (wherever applicable). e) Magnetizing characteristics test. f) Capacitance and tan delta measurement at minimum 10kV.		
11.06.00	VOLTAGE TRANSFORMERS/CAPACITOR VOLTAGE TRANSFOREMER a) Insulation resistance test. b) Polarity test. c) Ratio test. d) Dielectric test of oil (if applicable). e) Capacitance and tan delta measurement at minimum 10kV.		
11.07.00	SURGE ARRESTER a) Grading leakage current. b) Resistance of ground connection. c) Resistive current drawn at rated voltage after energisation.		
11.08.00	PHASING OUT The phasing out of all supplies in the station system shall be carried out.		
11.09.00	STATION EARTHING a) Check soil resistivity b) Check continuity of grid wires c) Check earth resistance of the entire grid as well as various sections of the same. d) Check for weld joint and application of zinc rich paint on galvanised surface. e) Dip test on earth conductor prior to use.		
11.10.00	CONDUCTOR STRINGING AND POWER CONNECTORS a) Physical check for finish b) Electrical clearance check c) Testing of torque by torque by torque wrenches on all bus power connectors and other accessories. d) Sag and tension check on conductors.		
11.11.00	INSULATORS Visual examination for finish damage, creepage distance, etc.		
11.12.00	WAVE TRAP a) Insulation resistance Test b) Visual check		
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SUB-SECTION – B-11

**FIRE PROOF CABLE PENETRATION
SEALING SYSTEM**

EPC PACKAGE FOR
PATRATU SUPER THERMAL POWER STATION EXPANSION
PHASE –I (3X 800MW)

TECHNICAL SPECIFICATION
SECTION – VI, PART-B
BID DOC NO. : CS-9585-001-2



CLAUSE NO.	TECHNICAL REQUIREMENTS		
1.00.00 1.01.00 1.02.00 1.03.00	CODES AND STANDARDS The fire proof cable penetration (FPCP) sealing system shall conform to the requirement of latest edition including amendments of BS:476 Part-20 Fire tests on Building materials and structures. Fire penetration seal complying with any other international standards will also be considered if it ensures performance equivalent or superior to standard listed above. The Bidder shall clearly indicate the standards adopted and furnish a copy of the English version of the latest editions of standards along with the bid, and shall clearly bring out the salient features for comparison.		
2.00.00 2.01.00 2.02.00	SYSTEM DESCRIPTION The fire proof cable penetration sealing system shall be of the following types; i) Type - A Type A fire sealing system is either Silicone foam or equivalent foam system or using individual blocks for each cable along with suitable frame work rated for one hour. Type A is to be implemented at floor openings below C&I panels, control panels/Boards etc. in CER & CCR. ii) Type-B Type B fire sealing system is any proven fire sealing system rated for one hour. This will comprise of rest of wall and floor crossings of cables/cable trays, opening below HT/LT Switchgears/board other than those covered under Type A. The penetration system, shall be installed immediately after the completion of cable termination in a particular switchboard/control panel/area after clearance from the Project Manager.		
3.00.00 3.01.00 3.02.00 3.03.00 3.04.00	GENERAL INFORMATION The cables shall generally be laid in cable trays/racks, conduits, ducts. The fire proof cable penetration system shall be designed in such a way that the existing supporting structure/cable is not disturbed. The penetration system shall be suitable for site condition at 50 ⁰ C ambient temperature and relative humidity of 100%. The penetration system of each wall/floor crossing shall be adequately designed/sized such that 20% addition of cables is possible at any later date without disturbance/wastage of material in the penetration system. Contractor shall plan the schedule of supply of the materials in consultation with Project Manager and use the material within stipulated shelf life of material. After award of work,		
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<p>drawings for each penetration seal shall be prepared by the contractor after verifying the actual installation of cables at site and approval shall be taken from the Project Manager's representative before proceeding with the actual work. The requirement of fire sealing material shall be quantified accordingly.</p> <p>Fire sealing material to be supplied shall be based on the net area to be sealed, wastage, thickness, density and other parameters as per the type test report approved under this contract.</p> <p>4.00.00 TECHNICAL REQUIREMENTS</p> <p>4.01.00 The fire proof cable penetration system shall fully comply with the requirements of BS:476 Part-20 and also to the requirements specified in this specification.</p> <p>4.02.00 The penetration system shall prevent spreading of fire in cable beyond the seal system in case of fire and shall have minimum 1 hour fire resistance rating.</p> <p>4.03.00 The penetration system shall be physically, chemically, thermally stable and shall be mechanically secure to the masonry/concrete/structural members. The system shall be mechanically robust and capable of giving satisfactory performance under vibrations encountered in power stations.</p> <p>4.04.00 The penetration system shall be capable of withstanding mechanical loads, foot traffic drop loads, vibrations, wind pressure, etc.</p> <p>4.05.00 The penetration system shall be completely gas and smoke tight.</p> <p>4.06.00 The penetration system shall retain integrity and perform satisfactorily even after remaining in water for long period.</p> <p>4.07.00 The materials used in FPCP sealing system shall be non-toxic and harmless to the working personnel.</p> <p>4.08.00 The penetration materials shall have no reaction with cable sheath/galvanising/painting of structural steel.</p> <p>4.09.00 The penetration materials shall have anti-rodent and anti-termite properties.</p> <p>4.10.00 The penetration materials shall have no shrinkage or cracking after the setting for the complete life of the power Plant.</p> <p>4.11.00 Under normal load, short circuit and fire conditions, cables may be subjected to movement and vibration. The FPCP sealing system shall be designed to withstand and perform satisfactorily under these conditions.</p> <p>4.12.00 The penetration system shall not affect the current carrying capacity of cables passing through it.</p> <p>4.13.00 Asbestos shall not be used in the construction of fire penetration seal system.</p>		
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CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
4.14.00	The penetration system shall have life expectancy of 40 years.		
4.15.00	The penetration system shall not emit any corrosive or toxic fumes or smoke on the unexposed face of the barrier.		
4.16.00	Any wastage of the compound during the process of mixing for preparing the FPCP sealing compound shall be to Contractor's account.		
4.17.00	For foam type of systems, only the foam shall form the penetration seal of specified rating, having the damming board removed after curing of the foam.		
5.00.00	PACKING AND STORAGE		
5.01.00	All materials and components of penetration system shall be supplied in packing to avoid contamination of materials due to dust/moisture and temperature during transit and storage. All packing shall be of durable quality and the date of expiry and the date of manufacture shall be printed on it.		
6.00.00	INSTALLATION		
6.01.00	The contractor shall take adequate care to ensure that cables are not damaged in any manner during penetration system installation.		
6.02.00	Wherever the floor/wall opening provided in the vicinity of penetration seals larger or smaller than that required for the cable fire penetration, these opening size can be reduced or increased in an approved manner by the contractor using the same materials as provided around the opening and of the same thickness. Generally the walls in the power station comprises of brickwork and the floors are made of RCC/steel work.		
6.03.00	The work to be carried out under this specification shall be done under the supervision of Project Manager's representative.		
6.04.00	All work shall be carried out in accordance with the agreed "field quality plan" and approved drawings. The "field quality plan" shall additionally specify the fire sealing material thickness, minimum cured density and other related parameters achieved in the approved type tests for the contract. The work shall be done to the satisfaction of the Project Manager and the same shall be subject to Project Manager's approval for acceptance.		
6.05.00	The installation shall be carried out in a neat workmen like manner by the skilled, experienced and competent workmen.		
6.06.00	Installation work at site shall be properly coordinated with other services.		
6.07.00	All materials being supplied or consumed during installation by the Contractor in the process of installation shall be of the best quality and according to standards. All materials shall be inspected and approved by the Project Manager before the same is used for installation work. Also regarding inspection of work, the engineer shall have the right to inspect at any stage during installation, testing and commissioning.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
6.08.00	The drilling and welding of building-steel or fixing supports etc. shall be carried out by contractor after taking prior approval of Project Manager.		
7.00.00	TYPE TESTS, ROUTINE & ACCEPTANCE TESTS		
7.01.00	All equipment to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.		
7.02.00	However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.		
7.03.00	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.		
7.04.00	The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design change". Minor changes if any shall be highlighted on the endorsement sheet.		
7.05.00	<p>Following Type test reports as per the setup and procedures given in subsequent clauses for the Fire proof cable penetration sealing system shall be submitted:</p> <ul style="list-style-type: none"> a) The accelerated ageing test b) Water absorption test c) Fire rating test d) Hose stream test e) Vibration test followed by fire rating test 		
7.05.01	Tests a, b, c and d should have been carried out on same test sample subsequently one after the other without any touching up/repair/modifications in the same sequence and in accordance with the clause 9.00.00. The test sample shall be assembled as per clause 8.00.00.		
7.05.02	Test indicated in clause 7.05.00 (e) above should have been carried out on a separate sample and as per the procedure indicated under clause 9.05.00.		
7.05.03	Physical, chemical and mechanical properties of various components/ingredients used should have been also be tested as a part of type tests.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
7.05.04	Test reports shall contain the following information: <div><div>1.</div>Type of penetration material tested</div> <div><div>2.</div>Details of various components/ingredients used alongwith their catalogue.</div> <div><div>3.</div>Physical, chemical and mechanical properties of various components/ ingredients used.</div> <div><div>4.</div>Description of the various test assemblies tested.</div> <div><div>5.</div>Details of method of conditioning.</div> <div><div>6.</div>The observations as called for in BS:476 Part-20 and technical specification.</div>			
7.06.00	ROUTINE & ACCEPTANCE TESTS <div>Routine and acceptance tests to be carried out on Type-A and Type-B cable fire sealing system shall be mutually agreed based on the type of fire sealing material offered before placement of award.</div>			
8.00.00	TEST SPECIMEN ASSEMBLY			
8.01.00	The test specimen shall be assembled as per enclosed drawing and shall resemble typical floor crossing cable penetration system.			
8.02.00	The test specimen shall be designed to seal an opening of adequate size in a concrete slab of 200 mm thickness. Two lengths of 300/600 mm wide ladder type cable tray shall be assembled with required layer of XLPE/PVC insulated, PVC sheathed unarmoured cables in touching formation. Type and number of cables in the cable tray shall be as per enclosed drawing. Cables shall be adequately clamped with tray at both the sides of the penetration as shown in the drawings. However, for penetration system with blocks which require staggered arrangement, cables can be clamped at an adequate distance from the penetration and the tray need not pass through the penetration seal.			
8.03.00	The opening in the test specimen then shall be sealed with fire proof cable penetration sealing materials.			
9.00.00	TEST PROCEDURES			
9.01.00	ACCELERATED AGEING TEST <div>The test specimen assembled as per clause 8.01.00 with damming board removed shall be subjected to accelerated ageing test by storing in air furnace where the temperature of the inside air shall be maintained at 85 degree centigrade for 168 hours. The temperature controlled furnace should have 7 air changes per hour approx.</div>			
9.02.00	WATER ABSORPTION TEST			
9.02.01	The test specimen shall be immersed in fresh clean water at a temperature of 20 deg. C \pm 2 deg C. The test specimen must be separated from the bottom and sides of the soak tank by			
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
<p>9.03.00</p> <p>9.03.01</p> <p>9.03.02</p> <p>9.03.03</p> <p>9.03.04</p> <p>9.03.05</p> <p>9.03.06</p> <p>9.03.07</p> <p>9.03.08</p>	<p>at least 10 mm and it shall be covered by approximately 25 mm of water. At the end of the 24 hour soak period the specimen shall be removed from water and mopped up with a damp cloth.</p> <p>FIRE RATING TEST</p> <p>The test specimen after withstanding water absorption test shall be subjected to fire rating test as per BS: 476 part-20.</p> <p>Oil/Gas fired furnace shall be used for heating. The furnace shall have achieved standard time/temperature characteristics for fire tests as per BS:476 part-20.</p> <p>The pressure inside the furnace at the time of test shall be within 1.5 ± 0.5 mm water gauge.</p> <p>Cables in the test specimen shall be anchored on the hot side to a structure independent of the barrier and its penetrations. This is to ensure that any differential movement between the penetration and the cable that could occur during a fire, is produced in the type tests and the reliability of the integrity of the penetration is checked.</p> <p>Cables shall be protruding between 1 to 2 metre, from the penetration face on the unexposed side and protruding into the furnace as far as it is practicable with a minimum length 750 mm. The ends of the cables shall be capped on the unexposed face to prevent gases and fumes to escape from the furnace during the fire.</p> <p>The test specimen shall be subjected to fire test with surface exposed to controlled fire in the furnace confirming to time/temperature characteristics specified in BS:476(20).</p> <p>During the test the temperature of both the faces of the fire stop i.e. one which is exposed to fire and other unexposed shall be measured by calibrated thermo couples after regular interval of 5 minutes.</p> <p>Atleast 3 thermo couples shall be provided for temperature measurement of each face. The results at the end of the test shall be interpreted for failure criteria as under.</p> <ol style="list-style-type: none"> 1. The system is deemed to have failed to maintain stability if there is a total collapse of the fire proof seal. 2. In case cracks are seen on the face of the fire stop or cracks through which the flame/ hot gas can pass the systems deemed to have failed to maintain integrity. The development of crack is characterised by appearance of black soot on cotton wool held near the penetration on the unexposed surface at a distance of about 100mm. 3. Failure shall be deemed to have occurred when the mean temperature of the unexposed surface of the specimen assembly increases by more than 140°C above the initial temperature or if the temperature of the unexposed surface is increased at any point by more than 180°C above the initial temperature. During the test the specimen shall meet all the three criteria simultaneously. 		
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
9.03.09	Temperature measurement on the unexposed side of penetration seal shall be measured by thermocouples at a distance of 25 mm from unexposed side of fire stop.		
9.04.00	HOSE STREAM TEST		
9.04.01	A hose stream test shall be conducted on the test specimen immediately following a fire resistance test on that assembly. The specimen must first be removed from the furnace since the hose stream is to be applied to the exposed face. This must be done quickly since it is the intention of the test that the stream be applied to the specimen whilst it is hot.		
9.04.02	The hose stream shall be long range narrow angle, (20° - 90° set at 30° included angle). High velocity water spray provided from a 28 mm hose discharging through an appropriate nozzle. The water pressure shall be 5 bar calculated at the base of the nozzle and the minimum flow rate shall be 4.7 litres/second. The stream shall be supplied perpendicularly to the exposed face of the test specimen with nozzle 3 m away from the exposed face.		
9.04.03	Application shall be for minimum of two and a half minutes per 9 sq.m. of the test specimen including the barrier.		
9.05.00	VIBRATION TEST		
9.05.01	The test assembly is to comprise a single ladder rack penetration in 1 m x 1m high normal section of fire barrier which is securely supported. The penetration seal shall be formed in the middle of the barrier around 1 m length of 600 mm ladder rack. The tray shall be fully loaded with cables in touching formation. The penetration assembly shall be formed symmetrically through the fire barrier as in service. The penetration sealant material shall then be allowed to cure for atleast as long as the time required for conditioning to constant mass. A vibration test shall then be conducted on the sample as set out below.		
9.05.02	The vibration shall be of 100 Hz frequency and of 0.5 mm amplitude (1.0 mm peak to peak) and this shall be applied to one rail of the ladder rack or the centre of a cross member secured to the two rails at 250 mm from the centre line of the penetration. This vibration shall be applied to the sample for the minimum period of 3 hrs. Immediately following this vibration test the barrier/ penetration assembly shall be successfully subjected to a fire test in accordance with clause no. 9.03.00.		
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SUB-SECTION – B-09

**CABLING, EARTHING AND LIGHTNING
PROTECTION**



CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>Annexure C</div> <div>एनटीपीसी NTPC</div>																																										
1.00.00	CODES AND STANDARDS																																												
1.01.00	<p>All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable .</p> <table><tr><td>IS:513</td><td>Cold rolled low carbon steel sheets and strips.</td></tr><tr><td>IS:802</td><td>Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.</td></tr><tr><td>IS:1079</td><td>Hot Rolled carbon steel sheet & strips</td></tr><tr><td>IS:1239</td><td>Mild steel tubes, tubulars and other wrought steel fittings</td></tr><tr><td>IS:1255</td><td>Code of practice for installation and maintenance of power cables upto and including 33 KV rating</td></tr><tr><td>IS:1367 Part-13</td><td>Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).</td></tr><tr><td>IS:2147</td><td>Degree of protection provided by enclosures for low voltage switchgear and control gear</td></tr><tr><td>IS:2309</td><td>Code of Practice for the protection of building and allied structures against lightning.</td></tr><tr><td>IS:2629</td><td>Recommended practice for hot dip galvanising of iron & steel</td></tr><tr><td>IS:2633</td><td>Method for testing uniformity of coating on zinc coated articles.</td></tr><tr><td>IS:3043</td><td>Code of practice for Earthing</td></tr><tr><td>IS:3063</td><td>Fasteners single coil rectangular section spring washers.</td></tr><tr><td>IS:6745</td><td>Methods for determination of mass of zinc coating on zinc coated iron & steel articles.</td></tr><tr><td>IS:8308</td><td>Compression type tubular in- line connectors for aluminium conductors of insulated cables</td></tr><tr><td>IS:8309</td><td>Compression type tubular terminal ends for aluminium conductors of insulated cables.</td></tr><tr><td>IS:9537</td><td>Conduits for electrical installation.</td></tr><tr><td>IS:9595</td><td>Metal - arc welding of carbon and carbon manganese steels - recommendations.</td></tr><tr><td>IS:13573</td><td>Joints and terminations for polymeric cables.</td></tr><tr><td>BS:476</td><td>Fire tests on building materials and structures</td></tr><tr><td>IEEE:80</td><td>IEEE guide for safety in AC substation grounding</td></tr><tr><td>IEEE:142</td><td>Grounding of Industrial & commercial power systems</td></tr></table>			IS:513	Cold rolled low carbon steel sheets and strips.	IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.	IS:1079	Hot Rolled carbon steel sheet & strips	IS:1239	Mild steel tubes, tubulars and other wrought steel fittings	IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating	IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).	IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear	IS:2309	Code of Practice for the protection of building and allied structures against lightning.	IS:2629	Recommended practice for hot dip galvanising of iron & steel	IS:2633	Method for testing uniformity of coating on zinc coated articles.	IS:3043	Code of practice for Earthing	IS:3063	Fasteners single coil rectangular section spring washers.	IS:6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.	IS:8308	Compression type tubular in- line connectors for aluminium conductors of insulated cables	IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.	IS:9537	Conduits for electrical installation.	IS:9595	Metal - arc welding of carbon and carbon manganese steels - recommendations.	IS:13573	Joints and terminations for polymeric cables.	BS:476	Fire tests on building materials and structures	IEEE:80	IEEE guide for safety in AC substation grounding	IEEE:142	Grounding of Industrial & commercial power systems
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1.02.00	DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.	
	DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors	
	BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.	
		Indian Electricity Act.	
		Indian Electricity Rules.	
	Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.		
	2.00.00 DESIGN AND CONSTRUCTIONAL FEATURE		
	2.01.00 Inter Plant Cabling		
	2.01.01 Interplant cabling for main routes shall be laid along overhead trestles/duct banks. Cables from main plant to switchyard control room shall be laid in overhead trestles or duct bank. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering. Directly burried cables, if essential ,shall not have concentration of more than 4 cables in one route. All buried cables, Cables for switchyard and CHP shall be armoured		
	2.01.02 Transformer yard		
In transformer yard cables shall be laid in overhead trestle. The main cable routes coming out from Main plant building and crossing the Transformer yard shall be laid in overhead trestles. In transformer yard, trestle height for rail/road crossing shall be suitable for movement of Generator Transformer with bushing.			
2.01.03 Trenches			
PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.			
2.01.04 No sub zero level cable vault/trenches shall be provided below control building/switchgear rooms in main plant.			
2.01.05 Cable Vault			
Clear access passage of at least 750mm wide & 2.1 mt clear heights shall be provided at entrances and along the cable trays in cable vault. Wherever the passage is through cable routes & across the cable tray the clear height shall not be less than 1.5 mts.			
Cable vaults shall be provided with adequate drainage facilities for drainage of fire water.			
Each cable vault should have at least two doors.			
Exit signs shall be provided near doors for personnel escape in case of emergency			
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2.01.06	<p>Boiler Area</p> <p>Two separate cable routes one on each side shall be provided for each boiler unit. Cables for on set of auxiliaries such as ID, FD, PA fan & half of the coal mills shall be routed in one route & for other set of auxiliaries through other route.</p> <p>Cable trays in boiler & ESP area shall be supported from the boiler and ESP structures. The same shall be coordinated with SG/ESP contractor.</p> <p>Cable trays in these areas shall be in vertical formation to avoid dust accumulation. No cable trenches shall be provided in boiler/ESP area.</p>		
2.01.07	<p>Turbine Hall Area</p> <p>a)Two separate cable routes shall be provided for cable routing of working and standby drives or different set/group (say 50% capacity) of auxiliaries.</p>		
2.01.08	<p>OffSite Area</p> <p>In offsite pumphouses, overhead cable tray arrangement shall be followed. However cable trenches may be considered below switchgear/mcc.</p> <p>Trestle In fuel oil pump house, overhead cable tray arrangement shall be provided. RCC trenches provided in MCC room shall be separated from fuel oil area to avoid oil accumulation.</p>		
2.01.09	<p>The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.</p>		
2.01.10	<p>Sizing criteria, derating factors for the cables shall be met as per respective chapters. However for the power cables, the minimum conductor size shall be 6 sq.mm. for aluminium conductor and 2.5 sq.mm. for copper conductor cable.</p>		
2.01.11	<p>Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to:</p> <ul style="list-style-type: none">Meet all safety requirementsSafeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc		
3.00.00	<p>EQUIPMENT DESCRIPTION</p>		
3.01.00	<p>Cable trays, Fittings & Accessories</p>		
3.01.01	<p>Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.</p>		
3.01.02	<p>Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per Clause No. 3.13.00 of this chapter.</p>		
3.01.03	<p>Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm.</p>		
3.01.04	<p>Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip</p>		
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	galvanised as per Clause No. 3.13.00 of this chapter. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm	
3.02.00	Support System for Cable Trays	
3.02.01	Cable tray support system shall be pre-fabricated out of single sheet as per enclosed tender drawings.	
3.02.02	<p>Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder</p> <p>a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.</p> <p>b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares fittings and accessories shall be prefabricated factory galvanised.</p> <p>c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanised surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied</p> <p>d. All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drilling and other machining operation.</p> <p>e. The typical arrangement of flexible support system is shown in the enclosed drawings and described briefly below:</p> <p>The main support channel and cantilever arms shall be fabricated out of 2.5 thick rolled steel sheet conforming to IS 1079.</p> <p>f. Cantilever arms of 320 mm, 620mm and 750 mm in length are required, and shall be as shown in the enclosed drawing. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.</p> <p>g. Support system shall be able to withstand</p> <ul style="list-style-type: none"> weight of the cable trays weight of the cables (75 Kg/Metre run of each cable tray) Concentrated load of 75 Kg between every support span. Factor of safety of minimum 1.5 shall be considered. 	
3.02.03	The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above or in the enclosed drawings are indicative only. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Bidder without any additional cost to	
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	<p>the Employer. The bidder shall submit the detailed drawings of the system offered by him alongwith the bid.</p>		
3.03.04	<p>FOR COAL HANDLING PLANT THE FOLLOWING SHALL ALSO BE APPLICABLE:</p> <p>a) All overhead cable routes shall be along the route of the conveyor gallery on separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 3.0M above the grade level except for rail/road crossings where it shall be at 8.0M above grade level. Tap offs from the overhead cable trestle can be through shallow trenches with prior approval of the Employer. Directly buried cable, if essential, shall not have concentration of more than 4 cables on one route.</p> <p>b) Cable trenches shall be provided only in Switchgear/MCC rooms.</p> <p>c) Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches, receptacles etc.</p> <p>d) Cables for PCS and BSS shall be routed along the conveyors through GI conduits.</p>		
3.04.00	<p>Pipes, Fittings & Accessories</p>		
3.03.01	<p>Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria</p>		
3.03.02	<p>GI Pipes shall be of medium duty as per IS: 1239</p>		
3.03.03	<p>Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.</p>		
3.03.04	<p>Hume pipes shall be NP3 type as per IS 458.</p>		
3.04.00	<p>Junction Boxes</p>		
3.04.01	<p>Junction box shall be made of Fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type. The box shall be provided with the terminal blocks, mounting bracket and screws etc. The cable entry shall be through galvanized steel conduits of suitable diameter. The JB shall have suitable for installing glands of suitable size on the bottom of the box. The JB shall be suitable for surface mounting on ceiling/structures. The JB shall be of grey color RAL 7035. All the metal parts shall be corrosion protected. Junction box surface should be such that it is free from crazings, blisterings, wrinkling, colour blots/striations. There should not be any mending or repair of surface. JB's will be provided with captive screws so that screws don't fall off when cover is opened. JB's mounting brackets should be of powder coated MS. Type test reports for the following tests shall be furnished:-</p> <p>(a) Impact resistance for impact energy of 2 Joules (IK07)as per BS EN50102</p> <p>(b) Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb.</p> <p>(c) Class of protection shall be IP 55.</p>		
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	(d) HV test.			
3.04.02	Terminal blocks shall be 1100V grade, of suitable current rating, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side the required cables/wire size. All internal wiring shall be of cu. Conductor PVC wire.			
3.05.00	Terminations & Straight Through Joints			
3.05.01	Termination and jointing kits for 33kV, 11 kV, 6.6 KV and 3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be Pre-moulded type or heat shrinkable type. Further Cold shrinkable type termination and jointing kits are also acceptable. The Cold shrinkable type kits shall be type tested as per relevant standards. Calculation to withstand the required fault level shall also be furnished in case of cold shrinkable type kits. 33 kV, 11 kV, 6.6 KV and 3.3kV grade joints and terminations shall be type tested and Type test reports as per IS:13573 Part-II and IEC60502 shall be furnished. Also, heat shrink material shall comply with requirements of ESI 09-13 (external tests). Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Cable joints and terminations should be with FRLS properties as per IEC 60754-1&2. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the tinned copper solderless crimping type cable lugs & ferrule or mechanical connectors (wherein bolts are tightened that shear off at an appropriate torque) as per DIN standard suitable for aluminium compacted conductor cables. (Tender drg. no 0000-211-POE –A-51-RA of cable lug attached at the end of this chapter)..			
3.05.02	Straight through joint and termination shall be capable of withstanding the fault level of 21 KA for 0.12 Sec. with dynamic peak of 52 KA for 33 KV system & of 40 kA for 0.12 sec with a dynamic peak of 100 kA for 11 kV, 6.6 KV & 3.3 KV system. Straight through joints shall have provisions for shield connection and earthing wherever required and complete with all accessories and consumables suitable for storage without deterioration at a temperature of 50 deg. C with shelf life of more than five years. 1.1 kV grade straight through joints shall also be of proven design			
3.05.03	1.1 KV grade Straight Through Joint shall be of proven design.			
3.06.00	Cable glands			
3.06.01	Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.			
3.07.00	Cable lugs/ferrules			
3.07.01	Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating			
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	<p>sleeve and shall suit the type of terminals provided on the equipments. Cable lugs and ferrule shall conform to DIN standards.</p>			
3.08.00	Trefoil clamps			
3.08.01	<p>Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the peak value of maximum system short circuit current.</p>			
3.09.00	Cable Clamps & Ties			
3.09.01	<p>The cable clamps/ties required to clamp multicore cables shall be of SS-316 material, 12mm wide, polyester coated ladder lock type. The clamps/ties shall have self locking arrangement & shall have sufficient strength. The cable clamps/ties shall be supplied in finished individual pieces of suitable length to meet the site requirements.</p>			
3.10.00	Receptacles			
3.10.01	<p>Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped gavanised or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break,AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polyimide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with inbuilt ELCB rated for suitable adjustable mA sensitivity ranging from 30-300 mA</p>			
3.12.00	Cable Drum Lifting Jack			
	<p>The jack for cable drum lifting shall be of screw type with 10 ton capacity. The cable drum jacks shall be manufactured from fabricated steel. The spindles supplied with the cable drum jack shall be manufactured using BSEN-24 grade steel bar with locking collars. Jack nests shall be of SG cast steel. Cable drum jack supplied shall have undergone load testing and reports for the same shall be submitted. At least Two Nos. of jacks shall be supplied for NTPC use. Contractor has to make arrangements for his own jacks for cable reeling/unreeling under his scope of installation.</p>			
3.13.00	Galvanising			
3.13.01	<p>Galvanising of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanising shall be uniform, clean smooth, continuous and free from acid spots.</p>			
3.13.02	<p>The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367 . The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified</p>			
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3.14.00	Welding		
3.14.01	The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595		
4.00.00	INSTALLATION		
4.01.00	Cable tray and Support System Installation		
4.01.01	Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.		
4.01.02	Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm in general. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per the approved guidelines/ drawings. Vendor shall design the support system along with tray, spacing etc in line with tray loadings/drawings.		
4.01.03	The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.		
4.01.04	The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval and the same shall be finalized at pre-award stage.		
4.01.05	All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/stenciled with identification numbers at every floor.		
4.01.06	In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.		
4.02.00	Conduits/Pipes/Ducts Installation		
4.02.01	The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.		
4.02.02	GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.		
4.02.03	Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material		
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4.02.04	<p>Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise</p> <table><tr><th>Conduit /pipe size (dia).</th><th>Spacing</th></tr><tr><td>Upto 40 mm</td><td>1 M</td></tr><tr><td>50 mm</td><td>2.0 M</td></tr><tr><td>65-85 mm</td><td>2.5 M</td></tr><tr><td>100 mm and above</td><td>3.0 M</td></tr></table>	Conduit /pipe size (dia).	Spacing	Upto 40 mm	1 M	50 mm	2.0 M	65-85 mm	2.5 M	100 mm and above	3.0 M
Conduit /pipe size (dia).	Spacing										
Upto 40 mm	1 M										
50 mm	2.0 M										
65-85 mm	2.5 M										
100 mm and above	3.0 M										
4.02.05	<p>For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.</p>										
4.03.00	<p>Junction Boxes Installation</p>										
4.03.01	<p>Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.</p>										
4.04.00	<p>Cable Installation</p>										
4.04.01	<p>Cable installation shall be carried out as per IS:1255 and other applicable standards.</p>										
4.04.02	<p>For Cable unloading, pulling etc following guidelines shall be followed in general:</p> <div><div>a)</div><div>Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.</div></div> <div><div>b)</div><div>While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.</div></div>										
4.04.03	<p>Cables shall be laid on cable trays strictly in line with cable schedule . Where specific cable layouts are not shown on drawings, Contractor shall route these as directed by the Project Manager</p>										
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4.04.04	Power and control cables shall be laid on separate tiers inline with the approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.T. cables shall be laid on top most tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two metre. All multicore cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with cable clamps/ties with self locking arrangement. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by cable clamps/ties with self locking arrangement at every five meter interval and at every bend. Fibre Optical cable shall be laid in trenches/trays or as decided by Employer.		
4.04.05	Bending radii for cables shall be as per manufacturer's recommendations and IS:1255.		
4.04.06	Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.		
4.04.07	No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.		
4.04.08	In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.		
4.04.09	Wherever few cables are branching out from main trunk route troughs shall be used.		
4.04.10	Wind loading shall be considered for designing support as well Cable trays wherever required.		
4.04.11	Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.		
4.04.12	The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.		
4.04.13	Separation At least 300mm clearance shall be provided between: - HT power & LT power cables, - LT power & LT control/instrumentation cables,		
4.04.14	Segregation 1) Segregation means physical isolation to prevent fire jumping. 2) All cables associated with the unit shall be segregated from cables of other units. 3) Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or		
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4.04.15	DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.				
	4) In switchyard, control cables of each bay shall be laid on separate racks/trays.				
	Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:				
	Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:				
	No. of cores in cable		No. of spare cores		
4.04.16	2C,3C		NIL		
	5C		1		
	7C-10C		2		
	14C and above		3		
	Directly Buried Cables				
4.04.17	a) Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS:1255 and the enclosed drawings showing cabling details.				
	b) RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.				
4.04.18	Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags. The cable tag requirements mentioned above shall prevail over Tag requirements mentioned elsewhere in this document for HT power, LT power & control cables.				
4.05.00	While crossing the floors, unarmoured cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.				
4.05.01	Cable Terminations & Connections				
4.05.02	The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor				
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	shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.		
4.05.02	Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Project Manager.		
4.05.03	The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.		
4.05.04	Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.		
4.05.05	All the cores of the control cable to be terminated shall have identification by providing ferrules at either end of the core, each ferrule shall be indelible, printed single tube ferrule and shall include the complete wire number and TB number as per the drawings. The ferrule shall fit tightly on the core. Spare cores shall have similar ferrules with suffix sp1, sp2, ---etc along with cable numbers and coiled up after end sealing.		
4.05.06	All cable terminations shall be appropriately tightened to ensure secure and reliable connections.		
5.00.00	EARTHING SYSTEM		
5.01.00	Earthing system shall be in strict accordance with IS:3043 and Indian Electricity Rules/Acts. Earthing system network/earthmat shall be interconnected mesh of mild steel rods buried in ground in the plant. All off-site areas shall be interconnected together by minimum two parallel conductors. The Contractor shall furnish the detailed design and calculations for Employer's approval. Contractor shall obtain all necessary statutory approvals for the system.		
5.02.00	The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects		
5.03.00	The material of the earthing conductors shall be as follows :		
	1)	Conductors above ground level and in built up trenches.	Galvanized steel
	2)	Conductors buried in earth	Mild steel
	3)	Earth electrodes	Mild steel rod
5.04.00	The sizes of earthing conductors for various electrical equipments shall be as below:		
	Equipment	Earth conductor buried in earth	Earth conductor above ground level & in built-up trenches
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	<p>a) Main earth grid 40 mm dia. MS rod 65 x 8mm GS flat</p> <p>b) 33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear --- 65 x 8mm GS flat</p> <p>c) 415 V MCC/ Distribution boards / Transformers --- 50 x 6mm GS flat</p> <p>d) LT Motors above 125 KW --- 50 x 6mm GS flat</p> <p>25 KW to 125 KW --- 25 x 6mm GS flat</p> <p>1KW to 25 KW --- 25 x 3mm GS flat</p> <p>Fractional House power motor --- 8 SWG GS wire</p> <p>e) Control panel & control desk --- 25 x 3 mm GS flat</p> <p>f) Push button station / Junction Box --- 8 SWG GI wire</p> <p>g) Columns, structures, cable trays and bus ducts enclosures --- 50 x 6mm GS flat</p> <p>h) Crane, rails, rail tracks & other non-current carrying metal parts 25 x 6mm GS flat</p>			
5.05.00	<p>Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of hand rails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise approved. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable.</p>			
5.06.00	<p>Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 meter. Wherever earth mat is not available, necessary connections shall be done by driving an earth electrode in the ground</p>			
5.07.00	<p>Neutral points of HT transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors.</p>			
5.08.00	<p>Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.</p>			
5.09.00	<p>Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.</p>			
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5.10.00		Suitable earth risers as approved shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.			
5.11.00		Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.			
5.12.00		Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.			
5.13.00		Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm.			
5.14.00		Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.			
5.15.00		A minimum earth coverage of 300 mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Earthing conductors crossings the road can be installed in pipes. Wherever earthing conductor crosses or runs at less than 300 mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same.			
5.16.00		Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.			
5.17.00		Earth pit shall be of treated type & shall be constructed as per IS:3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600mm. Earth pits shall be treated with salt and charcoal as per IS:3043. Test links shall be provided with bolted arrangement alongwith each earth pit, in order to facilitate measurement of earth resistance as & when required.			
5.18.00		On completion of installation continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by contractor.			
5.19.00		Earthing conductor shall be buried at least 2000mm outside the fence of electrical installations. Every alternate post of the fences and all gates shall be connected to earthing grid by one lead.			
5.20.00		Other Requirements of Earthing System:			
		Standard/Code		IEEE 80, IS 3043	
		Earthing System			
		Life expectancy		40 Years	
		System Fault Level		As per system requirement (B0)	
		Soil resistivity		Actual as per site conditions.	
		Min. Steel corrosion		0.12mm/year	
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		Depth of burial of main earth conductor	600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.				
		Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor.				
		Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.					
		Surface resistivity	- Gravel	3000 ohm-meter			
			- Concrete	500 ohm-meter			
6.00.00		LIGHTNING PROTECTION SYSTEM					
6.01.01		Lightning protection system shall be in strict accordance with IS:2309 .					
6.01.02		Lightning conductor shall be of 25x6mm GS strip when used above ground level and shall be connected through test link with earth electrode/earthing system					
6.01.03		Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc. as per approved drawings.					
6.02.00		Down Conductors					
		1.	Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.				
		2.	Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.				
		3.	All joints in the down conductors shall be welded type.				
		4.	Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.				
		5.	Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.				
		6.	All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.				
		7.	Lightning conductors shall not pass through or run inside GI Conduits.				
		8.	Testing link shall be made of galvanized steel of size 25x 6mm.				
		9.	Pulser system for lightning shall not be accepted.				
		10.	Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.				
7.00.00		TESTS					
7.01.01		All equipment to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this					
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CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>Annexure C</div> <div>एनटीपीसी NTPC</div>
7.01.02	<p>specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.</p> <p>However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.</p>		
7.01.03	<p>All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.</p>		
7.01.04	<p>The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.</p>		
7.02.00	<p>Type Test reports shall be furnished for the following</p>		
7.02.01	<p>Type tests on Cable Trays support system</p> <p>a) Test 1A:</p> <p>On main support channel type-C2 for cantilever arms fixed on one side only. A 3.5 meter length of main support channel shall be fixed vertically at each end to a rigid structure as per the fixing arrangement as shown in the enclosed drawing. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the points shown in the enclosed drawings and at the following load intervals:</p> <div><div>i)</div><div>Working load</div></div> <div><div>ii)</div><div>Working load + point load</div></div> <div><div>iii)</div><div>Off load</div></div> <div><div>iv)</div><div>Proof load + point load</div></div> <div><div>v)</div><div>Off load</div></div> <p>The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.</p> <p>B) Test 1B:</p> <p>Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2</p>		
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	<p>Test 2: On Main support channel type -C2 for cantilever arms fixed on both sides</p> <p>a) Test 2A: A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per the fixing arrangement as shown in the enclosed drawing. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals.</p> <div><div>i)</div><div>Working load</div></div> <div><div>ii)</div><div>Working load + Point load</div></div> <div><div>iii)</div><div>Off load</div></div> <div><div>iv)</div><div>Proof load + Point load</div></div> <div><div>v)</div><div>Off load</div></div> <p>The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied</p> <p>b) Test 2 B: The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side.</p> <p>Test 3 : Tests on Channel Fixed on Beam/Floor</p> <p>A length of main support channel section shall be fixed to steel structure/floor and have loads applied as shown in the drawing enclosed and as detailed below</p> <p>a) Test 3A : A length of steel structure shall be rigidly supported. It should be fitted on a meter length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place.</p> <p>b) Test 3B: With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place.</p> <p>c) Test 3C: With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line.</p> <p>The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded.</p> <p>Test 4 : Channel Insert Test</p> <p>A 2.5 m length of C1 channel fixed to the concrete wall/ steel structure as per actual site installation conditions. 6 nos. of 750 mm cantilever arms shall be attached to C1 channel as shown in enclosed drawing. Each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of</p>			
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		<p>100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals.</p> <div><div>i)</div><div>Working Load</div></div> <div><div>ii)</div><div>Working Load + Point Load</div></div> <div><div>iii)</div><div>Off Load</div></div> <div><div>iv)</div><div>Proof Load + Point Load</div></div> <div><div>v)</div><div>Off load</div></div> <p>The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied</p> <p>Test 5 : Channel nut slip characteristics (what ever applicable)</p> <p>Tests 5A1,5A2,5A3 : A length of channel C1 section 200mm long shall have fitted bracket with the two bolt fixing as shown in drawing enclosed. With loads applied at the position shown in drawing enclosed nut slip shall be determined with bolt torque of 30NM, 50 NM and 65 NM No fewer than three measurements shall be made for each torque setting.</p> <p>A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM.</p> <p>Tests 5B1,5B2,5B3: The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing as shown in drawing enclosed. With loads applied at the position shown in drawing, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting.</p> <p>A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM.</p> <p>Test 6 Weld Integrity Test</p> <p>After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.</p>			
7.02.02		Cable termination kit and straight through joints should have been tested as per IS:13573 for 3.3kV grade & above.			
7.03.00		Routine/ Acceptance Tests			
7.03.01		Routine Tests			
		a) Routine tests as per specification and applicable standards shall be carried out on all requirements/items covered in the specification.			
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7.03.02	b) Physical & dimensional check on all equipments as per approved drawings/standards		
	c) HV/IR as applicable.		
	d) Check/measurement of thickness of paint/zinc coating/nickel-chrome plating as per specification & applicable standard.		
	Acceptance Test		
	a) Galvanising Tests as per applicable standards		
	b) Welding checks		
	c) Deflection tests on cable trays:		
	d) One piece each of 2.5m length of cable tray of 300mm & above shall be taken as sample from each offered lot. It shall be supported at both end & loaded with uniform load of 76 kg/meter along the length of cable tray. The maximum deflection at the mid-span of each size shall not exceed 7mm.		
	d) Proof load tests on cable tray support system		
	i) Tests on Main Support Channel shall be done if only C1 Channel are in scope of supply and cantilever arms shall be fitted on one side. This test shall be same as test 4 of type test.		
8.00.00	ii) Test on Main Support Channel shall be done with C2 channel and cantilever arms fitted on both sides, if C2 channels are in scope of supply. This test shall be same as test 2A of type test. Then test (i) above shall not be done.		
	iii) Nut slip characteristic test (it shall support minimum load of 350kg before nut slips with a bolt torque of 65 NM). This test shall be same as test 5B3 of type test. The procedure for carrying out tests at “d” above shall be as per details given in Type Tests in specification thereafter Die-Penetration test shall be carried out to check weld integrity.		
	e) The above acceptance tests shall be done only on one sample from each offered lot.		
	COMMISSIONING		
8.01.01	The Contractor shall carry out the following commissioning tests and checks after installation at site. In addition the Contractor shall carry out all other checks and tests as recommended by the Manufacturers or else required for satisfactory performance..		
8.01.02	Cables		
	a) Check for physical damage		
	b) Check for insulation resistance before and after termination/jointing.		
	c) HT cables shall be pressure tested (test voltage as per IS:7098) before commissioning.		
	d) Check of continuity of all cores of the cables.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
8.02.00	<p>e) Check for correctness of all connections as per relevant wiring diagrams. Any minor modification to the panel wiring like removing/inserting, shorting, change in terminal connections, etc., shall be carried out by the Contractor.</p> <p>f) Check for correct polarity and phasing of cable connections.</p> <p>g) Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc.</p> <p>h) Check for provision of correct cable tags, core ferrules, tightness of connections.</p> <p>Cable trays / supports and accessories</p> <p>1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.</p> <p>2) Check for continuity of cable trays over the entire route.</p> <p>3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.</p> <p>4) Check for earth continuity and earth connection of cable trays.</p>		
	<p>8.03.00</p> <p>Earthing and Lightning protection system</p> <p>1) Earth continuity checks.</p> <p>2) Earth resistance of the complete system as well as sub-system.</p>		
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SUB-SECTION – B-10

STATION LIGHTING

EPC PACKAGE FOR
PATRATU SUPER THERMAL POWER STATION EXPANSION
PHASE –I (3X 800MW)

TECHNICAL SPECIFICATION
SECTION – VI, PART-B
BID DOC NO. : CS-9585-001-2



CLAUSE NO.	TECHNICAL REQUIREMENTS		
1.00.00	GENERAL		
1.01.00	This specification covers the general description of design, manufacture and construction features, testing, supply, installation and commissioning of the Station Lighting system equipment.		
2.00.00	CODES AND STANDARDS		
2.01.00	All standards and codes of practice referred to herein shall be the latest edition including all applicable official amendments & revisions as on date of bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards & codes.		
2.02.00	Lighting Fixtures and Accessories		
	IS:1913	General and safety requirements for luminaires.	
	IS:2148	Flame proof enclosures of electrical apparatus.	
	IS:418	Tungsten filament general service electric lamps.	
	IS:1258	Bayonet lamp holders.	
	IS:1534	Ballast for fluorescent lamps.	
	IS:1569	Capacitors for use in tubular fluorescent, high pressure mercury vapour and low pressure sodium vapour discharge lamp circuit.	
	IS:1777	Industrial luminaire with metal reflectors.	
	IS:2215	Starters for fluorescent lamps.	
	IS:2418	Tubular fluorescent lamps for general lighting services.	
	IS:3323	Bi-pin lamp holders for tubular fluorescent lamps.	
	IS:3324	Holders for starters for tubular fluorescent lamps.	
	IS:4013	Dust-tight electric lighting fittings.	
	IS:8224	Electric Lighting fittings for Division 2 areas.	
	IS:10276	Edison screw lamp holders.	
	IS:10322	Luminaires.	
	IS:13021	AC Supplied Electronic Ballasts for tubular fluorescent lamps.	
	2.03.00	Lighting Panels, Switch-boxes, Receptacles and Junction Boxes	
	IS:2147	Degree of protection provided by enclosures for low-voltage switchgear and control gear.	
	IS:1293	Plugs & socket outlets of rated voltage upto and Including 250volts & rated current upto and including 16 Amps.	
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	IS:2551	Danger notice plates.	
	IS:13947	Low voltage switchgear and controlgear	
	IS:3854	Switches for domestic and similar purposes.	
	IS:6875	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V AC and 1200 V DC.	
	IS:13703	Low voltage fuses for voltages not exceeding 1000V AC or 1500 V DC.	
2.04.00	Conduits, Pipes and Accessories		
	IS:2667	Fittings for rigid steel conduit for electrical wiring.	
	IS:3837	Accessories for rigid steel conduits for electrical wiring.	
	IS:9537	Conduits for electrical installations.	
2.05.00	Lighting Wires/Cables		
	IS:694	PVC insulated cables for working voltages upto and including 1100 V	
	IS:3961	Recommended current ratings for cables.(PVC Insulated and PVC sheathed heavy duty cables and light duty cables).	
	IS:8130	Conductors for insulated electric cables and flexible cords.	
	IS:10810	Methods of tests for cables.	
2.06.00	LED Luminaries		
	16101:2012	General Lighting. LEDs and LED modules Terms and definitions	
	16102(Part 1):2012	Self Ballasted LED Lamps for General Lighting Services. Part-1 Safety Requirements.	
	16102(Part 2):2012	Self Ballasted LED Lamps for General lighting Services. Part-2 Performance Requirements.	
	16103(Part I):2012	LED modules for General lighting Safety Requirements.	
	15885(Part 2/Sec. 13) :2012	Lamp control gear Part 2 particular Requirements Section 13 d.c. or a.c.	
	16104:2012	Supplied Electronic control gear for LED modules d.c. or a.c. Supplied Electronic control gear for LED modules - Performance Requirements.	
	16105:2012	Method of Measurement of Lumen maintenance of Solid-state Light (LED) Sources.	
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
2.07.00	16106:2012	Method of Electrical and photometric Measurements of Solid State Lighting (LED) Products	
	16107:2012	Luminaires Performance	
	16108:2012	Photobiological safety of Lamps and Lamp Systems	
	IS 513	Cold rolled low carbon steel sheets and strips	
	IS 12063	Classification of degree of protection provided by enclosures.	
	IS 14700	Electro magnetic compatibility (EMC) – Limits (Part 3/Sec. 2) for Harmonic current emission – THD < 15% (equipment, input current < 16 Amps. per phase.	
	IS 9000 (Part 6)	Environment testing: Test Z – AD: composite temperature/humidity cyclic test.	
	IS 15885	Lamp control gear: particular requirements for (Part 2/Sec. 13) DC or AC supplied electronic control gear IS 16004 – 1 and 2) for LED modules.	
	IS 4905	Method for random sampling	
	Electrical Installation Practices & Miscellaneous		
	IS:1944	Code of practice for lighting of public thorough fare	
	IS:3646	Code of practice for interior illumination.	
	IS:5572	Classification of Hazardous areas (other than Mines) having flammable gases and Vapours for electrical installation	
	S:6665	Code of practice for industrial lighting.	
	.	National Electrical Code	
	-	Indian Electricity Rules.	
	IS:5	Indian Electricity Act Colour for ready mixed paints & enamels.	
	IS:280	Mild steel wires for general engineering purposes.	
	IS:374	Electric ceiling type fans & regulators.	
	IS:732	Code of practice for electrical wiring installations.	
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	IS:1255 IS:2062 IS:2629 IS:2633 IS:2713 IS:3043 IS:5216 IS:5571 BS:6121	Code of practice for installation and maintenance of power cables Upto and including 33KV rating. Steel for general structural purposes Recommended practice for hot-dip galvanizing of iron and steel. Methods for testing uniformity of coating of zinc coated articles. Tubular steel poles for overhead power lines. Code of practice for earthing Guide for safety procedures and practices in electrical work. Guide for selection of electrical equipments for hazardous areas. Mechanical cable glands	
3.00.00	LIGHTING SYSTEM DESCRIPTION		
3.01.00	The illumination of various indoor and outdoor areas in the main plant & offsite area shall be provided as described here. The lighting system of various areas shall comprise of the following systems as identified in Annexure-B: <ul style="list-style-type: none"> (a) Normal AC Lighting System (b) Emergency AC Lighting System (c) DC Lighting System 		
3.02.01	Normal AC Lighting System Normal AC lighting system 415V, 3Phase, 4wire, will be fed from lighting panels (LPs) which in turn will be fed from the lighting distribution boards (LDBs)/Switch board MCC.		
3.02.02	Emergency AC Lighting System This system shall be provided for certain important areas in the main plant. The lighting fixtures connected to this system shall be normally "ON" along with the normal AC system. These will be fed from emergency lighting panels (ELPs) which in turn will be fed 3-phase, 4-wire supply from the emergency lighting distribution boards (ELDB'S). These lights will go off for a few seconds in case of AC supply failure at Emergency Switchgear, but shall be automatically restored when Emergency Switchgear is energised by Diesel generator set.		
3.03.00	DC Lighting System		
3.03.01	At strategic locations in the main plant, a few lighting fixtures fed from 220V, DC supply, shall be provided to enable safe movement of operating personnel and access to important control points during an emergency, when both the normal AC and Emergency Lighting system fail. These lighting fixtures will be fed from 220V DC LDBs which in turn will be fed from DC lighting panels.		
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3.03.02	The supply to the DC lighting panels shall be automatically switched ON in case of loss of AC supply at station service switchgear as well as Emergency switch-gear. The DC supply will be automatically switched OFF after about 3 minutes following the restoration of supply to normal AC or emergency AC lighting system.			
3.03.03	Emergency DC lighting is to be provided, through self-contained DC emergency fixtures with four hours back-up duration, at strategic locations, in auxiliary/offsite buildings wherever DC supply system is not available. The fixtures shall be switched 'ON' automatically in case of failure of AC supply.			
3.03.04	For Coal Handling plant. 100W, 220V DC Lighting fixture shall be provided in underground portion of conveyor, each switchgear room, control room, office room, pump house, each drive floor of TPs, staircases of various TPs and buildings and each local control area. DC lighting fixtures shall be fed from 220V DC LDB which in turn will be fed from CHP DC system. The supply to the DC lighting panels shall be automatically switched ON in case of loss of normal AC supply.			
4.00.00	DESIGN PHILOSOPHY <div><div>1.</div><div>A comprehensive illumination system shall be provided in the entire project areas under bidder's scope.</div></div> <div><div>2.</div><div>All outdoor lighting system shall be automatically controlled by synchronous timer. Provision to bypass the timer shall be provided in the panel.</div></div> <div><div>3.</div><div>The system shall include distribution boards, normal/ emergency lighting panels, lighting fixtures, junction boxes, receptacles, switch boards, lighting pole/masts, conduits, cables and wires, etc. The system shall cover all interior and exterior lighting such as area lighting, including Transformer yard & Switch yard area, aviation obstruction lighting, Street lighting, security lighting, etc. The constructional features of lighting distribution boards shall be similar to AC/DC distribution boards described in chapter of LT Switchgear. Outgoing circuits in LPs shall be provided with MCBs of adequate ratings.</div></div> <div><div>4.</div><div>The illumination system shall be designed on the basis of best engineering practice and shall ensure uniform, reliable, aesthetically pleasing and glare free illumination. The lighting fixtures shall be designed for minimum glare. The design shall prevent glare/luminous patch seen on VDU/ Large video screens, when viewed from an angle. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection. The diffusers/ louvers used in fixtures shall be made of impact resistant polystyrene sheet and shall have no yellowing property over a prolonged period. The Lux levels to be adopted for various area are indicated at Annexure - A. (placed at the end of this Chapter).</div></div> <div><div>5.</div><div>Different Lighting Systems envisaged for various plant areas are indicated in Annexure-B: While finalizing the detailed layout of lighting fixtures, the position/location and layout of equipments should be taken into account to have adequate illumination at desired locations.</div></div> <div><div>6.</div><div>LED Luminaires: LED Luminaires shall be used for the lighting of all the indoor & outdoor areas in bidder's scope. However for DC lighting, hazardous areas & aviation lighting etc. conventional type luminaires shall be used. However, aviation light in Lighting Mast shall be of LED type. In false ceiling area LED luminaires shall be recessed</div></div>			
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	<p>mounting type & in non-false ceiling area the LED luminaires shall be surface mounting type.</p> <p>The individual lamp wattage for LED shall be upto 3 watt. Fractional wattage LEDs are also acceptable. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall be not less than 80 Lm/W. Suitable heat sink shall be designed & provided in the luminaire. The LED used in the luminaires shall have colour rendering index (CRI) of Min 80. Colour designation of LED shall be “cool day light” (min 5700K) type for indoor areas. However for outdoor areas, the colour temperature of LED shall be min. 4000K, including rough & dust prone areas. LED shall conform to the LM 80 requirements.</p> <p>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.</p> <p>The connecting wires used inside the system, shall be low smoke halogen free, fire retardant type and fuse protection shall be provided in input side specifically for LED luminaires.</p> <p>Care shall be taken in the design that there is no water stagnation anywhere in the housing of luminaire. The entire housing shall be dust and water proof protection as per IS 12063.</p>																			
7.	Driver Circuit	<p>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 chip manufacturer.</p> <p>LED Drivers shall have following control & protections:-</p> <ul style="list-style-type: none">• Suitable precision current control of LED.• Open Circuit Protection• Short Circuit Protection• Over Temperature Protection• Overload Protection• Surge Protection																		
8.	<p>Apart from maintenance factor as given below, Temperature correction factor shall be considered in the lighting design for fixtures located in non air conditioned area.</p> <table><tr><td>(a.)</td><td>Office area (air conditioned)</td><td>:</td><td>0.8</td></tr><tr><td>(b.)</td><td>Office area (non air conditioned) and other indoor area</td><td>:</td><td>0.7</td></tr><tr><td>(c.)</td><td>Dust prone indoor and outdoor area</td><td>:</td><td>0.6</td></tr><tr><td>(d.)</td><td>Coal Handling area, Ash Handling Conveyor /Transfer Points etc.</td><td>:</td><td>0.5</td></tr></table>				(a.)	Office area (air conditioned)	:	0.8	(b.)	Office area (non air conditioned) and other indoor area	:	0.7	(c.)	Dust prone indoor and outdoor area	:	0.6	(d.)	Coal Handling area, Ash Handling Conveyor /Transfer Points etc.	:	0.5
(a.)	Office area (air conditioned)	:	0.8																	
(b.)	Office area (non air conditioned) and other indoor area	:	0.7																	
(c.)	Dust prone indoor and outdoor area	:	0.6																	
(d.)	Coal Handling area, Ash Handling Conveyor /Transfer Points etc.	:	0.5																	
9.	<p>All lighting fixtures and control gears shall be powder coated. All outdoor fixtures shall be weather proof and of min. IP55 degree of protection.</p>																			
10.	<p>Lighting panels shall be powder coated with color shade RAL9002. Lighting panels shall have min. IP55 degree of protection.</p>																			
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	<p>11. Wires of different phase shall normally run in separate conduit.</p> <p>12. Power supply shall be fed from 415 / 240 V normal AC supply, emergency AC supply and 220V DC supply through suitable number of conveniently located lighting distribution boards (LDB) and lighting panels (LP). AC lighting supply shall be isolated from main supply by isolation transformers of max. rating of 100KVA and fault level restricted to 3 KA at Lighting Panels.</p> <p>13. Atleast one 6/16A, 240V AC universal socket outlet with switch shall be provided in offices, cabins, etc. Further 20A, 240V AC industrial receptacle with switch shall be provided strategically in all industrial areas. Suitable number of 63A, 3ph, 415V AC industrial receptacles shall be provided for entire plant for welding purposes, particularly near all major equipment and at an average distance of 50m. Atleast one 63A, 3ph, 415V AC receptacle shall be provided in each floor of off-site buildings/ structures.</p> <p>14. In the hazardous areas like Hydrogen generation plant, fuel oil handling areas or any other gas/ liquid fuel storage/ handling areas in bidder's scope, lighting shall be flame proof.</p> <p>15. The type of fixtures, LP, JB, and receptacle used in Hydrogen generation plant building shall be suitable for group II C as per IS: 2148 or class I, Division II as per NEC 70-428.</p> <p>16. All flourescent lamps shall be have "Cool day light" colour designation. The mirror optics type flourescent fixtures shall have no irridescence effect. Fixtures with better efficiency and upgraded proven system may also be considered In candescent lamps may be used only with DC Lighting.</p> <p>17. Aviation warning lights shall be provided as per the recommendations of ICAO and Director general of civil aviation, India. The arrangement of light should be marked such that the object is indicated from every angle in azimuth. The aviation warning lighting system shall also conform to the latest Indian standard IS 4998.</p> <p>18. Contractor shall demonstrate the average lux level achieved for different areas as per specification requirements, after completion of the lighting work, at site to the satisfaction of engineer-in-charge.</p>		
4.01.00	Ballasts		
4.01.01	All fluorescent fixtures except for Class-I, Div-II fittings/ increased safety fittings (Div-II/Hazardous Area) shall be provided with electronic ballasts.		
4.02.00	All luminaires and their accessories and components shall be of type readily replaceable by available Indian makes.		
4.03.00	Fans & Regulator		
4.03.01	Ceiling Fans, to be provided in non air-conditioned office/control room area. Further tentatively one (1) no. ceiling fan shall be provided for 10 sq.m area, at suitable mounting height. The ceiling fans shall be suitable for operation on 240 V +/-10%, 50 Hz, AC supply comprising of class 'E' or better insulated copper wound single phase motor, 1200mm sweep, aerodynamically designed well balanced AL blades (3 Nos.), down rod, die cast aluminium housing, capacitor, suspension hook, canopies etc. finished in stove enameled		
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<p>4.04.00</p>	<p>white or with electro static powder coating. Power factor of fans shall not be less than 0.9. Fan regulators shall be stepped electronic type suitable for operation on 240V +/- 10% AC supply.</p> <p>Junction Boxes, Conduits, Fitting & Accessories, Pull Out Boxes:</p> <p>Junction box for indoor lighting shall be made of fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type.</p> <p>Junction boxes for street lighting poles and lighting mast if applicable , shall be deep drawn or fabricated type made of min. 1.6 mm thick CRCA Sheet. The box shall be hot dip galvanized. The degree of protection shall be IP55.</p> <p>All switches and receptacles upto 16A shall be modular type. These shall be provided with pre-galvanized/galvanized modular switchbox & plate.</p> <p>Conduits, Pipes and Accessories Galvanised heavy duty steel conduits for normal area and galvanised heavy duty steel conduits with an additional epoxy coating for corrosive area shall be offered. Alternatively glass reinforced epoxy conduits with comparable compressive and impact strength with that of heavy duty steel conduits may be offered.</p> <p>Rigid steel conduits shall be heavy duty type, hot dip galvanised conforming to IS : 9537 Part-I & II shall be suitable for heavy mechanical stresses, threaded on both sides and threaded length shall be protected by zinc rich paint. Conduits shall be smooth from inside and outside.</p> <p>Flexible conduit shall be water proof and rust proof made of heat resistant lead coated steel.</p> <p>Pull out boxes shall be provided at suitable interval in a conduit run .Boxes shall be suitable for mounting on Walls, Columns, Structures, etc.. Pull-out boxes shall have cover with screw and shall be provided with good quality gasket lining. Pull out boxes used outdoor shall be weather proof type suitable for IP: 55 degree of protection and those used indoor shall be suitable for IP: 52 degree of protection. Pull out box & its cover shall be hot dip galvanized.</p>		
<p>4.05.00</p>	<p>Lighting Wires</p>		
<p>4.05.01</p>	<p>Lighting wires shall be 1100 V grade, light duty PVC insulated unsheathed, stranded copper/aluminium wire for fixed wiring installation. Colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R, Y, B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively. Minimum size of wire shall not be less than 1.5.sq.mm. for copper and 4 sq.mm. for aluminium.</p>		
<p>4.06.00</p>	<p>Lighting Poles</p>		
<p>4.06.01</p>	<p>The Street Light system and peripheral lighting shall be designed generally in line with design guidelines. The Poles shall be mounted above ground using base plate and minimum height of pole shall be 8 mtrs The poles shall be hot-dip galvanized as per IS2629/ IS2633/ IS4759. The average coating thickness of galvanizing shall be min. 70 micron. The System shall be capable of withstanding the appropriate wind load etc as per IS 875 considering prevailing soil/ site condition considering all accessories mounting on pole.</p>		
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	<p>The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB.</p>		
4.07.00	Lighting Masts		
4.07.01	<p>Lighting Mast shall be of continuously tapered polygonal cross section hot dip galvanised. The Mast shall be of 30 M or suitable height with lantern carriage to enable raising/lowering for ease of maintenance, including the Head Frame, Double Drum Winch, continuous stainless steel wire rope, in built power tool, luminaires, suitable aviation warning light, lightning alongwith necessary power cables within the mast. The mast shall be delivered in not more than three sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast. The Mast together with the fixtures shall be capable of withstanding the appropriate wind loads as per IS: 875. The Mast shall be fabricated from special steel plates conforming to BS-EN10-025 and folded to form a polygonal section. Suitable feeder pillar with TPN MCB, contactors, timer, MCB and other necessary accessories for operation & protection of the mast and fixtures shall be provided.</p>		
4.08.00	<p>Lighting fixtures shall generally be group controlled directly from lighting panel. However, in office areas, control shall be provided through switch boxes. Each switch shall control a maximum of three fluorescent fixtures.</p>		
4.09.00	<p>A.C. normal, AC emergency and DC system wiring shall run throughout in separate conduits. Wires of different phase shall run in different conduits.</p>		
4.10.00	<p>Lighting panels, etc. shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, fans, single phase receptacles etc. shall be earthed by means of separate earth continuity conductor. The earth continuity conductor 14 SWG GI wire shall be run alongwith each conduit run. Cable armours shall be connected to earthing system at both the ends.</p>		
4.11.00	<p>Alternately Vendor may offer technically superior and proven product subject to approval of employer.</p>		
4.12.00	<p>Occupancy based Passive Infra-red sensors</p> <p>The sensors shall be recess mounted, programmable type suitable for lighting load of 6A with variable off delay settings. The detection area shall be minimum 5 metres for standard room height of 3mt. All the calibrated settings shall be stored in non-volatile memory of PIR sensor which shall be unaffected by power supply fluctuations. Necessary 16A contactor shall be supplied alongwith each sensor & shall be located inside the switch box</p>		
5.00.00	TESTS		
5.01.00	<p>For LED Fixture</p> <p>a) The contractor shall carry out the type tests as listed in this specification on the following types of LED fixtures to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant price schedule of bid document and the same shall be considered for the evaluation of the bids.</p> <p>LED fixtures (Type test shall be conducted on one rating each of following type of LED fixtures. Rating for test conduction shall be decided by the employer during detailed engineering)</p> <p>a) High bay fixture.</p> <p>b) Well glass fixture.</p>		
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	<div><div><div>c)</div><div>Street light fixture</div></div><div><div>d)</div><div>Surface mounted type fixture.</div></div><div><div>e)</div><div>Recessed mounted type fixture.</div></div></div> <p>The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.</p> <div><div><div>b)</div><div>The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.</div></div><div><div><div>c)</div><div>In case the contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the owner for waival of conductance of such type test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The owner reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.</div></div></div></div>									
5.02.00	For all other Station lighting equipment: <div><div><div>a)</div><div>All equipment to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.</div></div><div><div><div>b)</div><div>However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.</div></div></div></div>									
5.03.00	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.									
5.04.00	Selection of samples for type test, acceptance test & routine test and acceptance criteria for all the items shall be as per relevant I.S									
5.05.00	Type test reports of the following items as per technical specification requirements/ standards shall be submitted for approval. <table><tr><th>SL NO.</th><th>DESCRIPTION</th></tr><tr><td>i.</td><td>Lighting fixtures of each type</td></tr><tr><td>ii.</td><td>Lighting panel of each type (Degree of Protection)</td></tr></table>				SL NO.	DESCRIPTION	i.	Lighting fixtures of each type	ii.	Lighting panel of each type (Degree of Protection)
SL NO.	DESCRIPTION									
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iii. Junction Box of each type.

Type test reports for LED as per standards for following shall be submitted for approval.

1. Visual and Dimension check
2. Proof of procurement of LEDs
3. Safety tests
a) Marking
b) Construction
c) Provision for Earthing
d) External and Internal wiring
e) Protection against electrical shock
f) Endurance and Thermal
g) Insulation resistance & electrical strength
h) Resistance to heat fire & tracking
i) Resistance to Humidity
4. Fire Retardant test
5. Performance tests (electrical, Photometric color and Life)
6. Burn-in Test
7. Power Cycling
8. Temperature rise test
9. Emission Tests
a) Radiated & conducted emission
b) Harmonics & flickers
10. Immunity tests

In addition, following test reports to be submitted for LED chip/LED luminaire:

- LED parameters like Lumen per watt, CRI, Beam angle from manufacturer.
- LM 80/IS: 16105 report.
- LM 79/IS: 16106 report.



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5.06.00 5.06.01 5.06.02 5.07.00 5.07.01 5.07.02	<p>Acceptance Test and Routine Test</p> <p>All lighting fixtures, lamps and other items shall be subjected to acceptance and routine test, as per relevant specified standards.</p> <p>Junction boxes, switch boxes, receptacle enclosure etc. shall be subjected to physical and dimensional checks also.</p> <p>Galvanizing Tests</p> <p>The quality of galvanizing shall be smooth, continuous, free from flux stains and shall be inspected visually.</p> <p>In addition following tests shall be conducted as acceptance tests.</p> <ul style="list-style-type: none"> (a) Uniformity of coating - The coating of any article shall withstand for one (1) minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal. (b) The quality of cadmium/zinc plating on items with screw threads shall be free from visible defects such as unplated areas, blisters and modules and shall be inspected visually. (c) In addition, the plating thickness shall be determined microscopically/ chemically or electronically. 		
6.00.00	<p>COMMISSIONING CHECKS</p> <ol style="list-style-type: none"> 1. On completion of installation work, the Contractor shall request the Project manager for inspection and test with minimum of fourteen (14) days advance notice. 2. The Project manager shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor. 3. The installation shall be then tested and commissioned in presence of the Project manager. 4. The contractor shall provide all, men material and equipment required to carry out the tests. 5. All rectifications, repair or adjustment work found necessary during inspection, testing and commissioning shall be carried out by the Contractor without any extra cost. The handing over the lighting installation shall be effected only after the receipt of written instruction from the Employer/his authorized representative. 6. The testing shall be done in accordance with the applicable Indian Standards and codes of practices. The following tests shall be specifically carried out for all lighting installation. <ul style="list-style-type: none"> (a) Insulation Resistance. (b) Testing of earth continuity path. (c) Polarity test of single phase switches. 		
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(d) Functional checks.

7. The lighting circuits shall be tested in the following manner:

- (a) All switches ON and consuming devices in circuit, both poles connected together to obtain resistance to earth.
- (b) Insulation resistance between poles with lamps and other consuming devices removed and switches ON.




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ANNEXURE-A

SI No.	Location**	Average Illumination Level (Lux)	Type of Fixture
(a)	Turbine Hall operating floor	200	High/medium bay LED luminaire
(b)	Turbine Hall Other Platforms	200	LED high/medium bay, LED well glass fixtures
(c)	Switchgear rooms, Charger, Rectifier room	200	Industrial type LED Luminaire
(d)	Control room, computer room, control equipment room	350	LED luminaire equivalent to Mirror optics with anti-glare features or downlighter.
(e)	Offices, conference rooms, etc.	300	Decorative mirror optics Type LED luminaire or LED downlighter
(f)	Battery rooms	100	Totally enclosed corrosion Proof LED Luminaire
(g)	Transformer yard	20 (general) 50 (on equipment)	LED Luminaire
(h)	Boiler platforms	100	LED well glass fixtures,
(i)	Diesel generating room /enclosure, Compressor room, pump house etc.	150	LED medium bay/ Industrial type LED Luminaire
(j)	Fuel oil pump house	150	Flame proof fluorescent fixtures suitable for division-2 hazardous area
(k)	Cable galleries/vault	50	Industrial type LED Luminaire
(l)	Street lighting- primary roads secondary roads	20 10	LED street lights
(m)	Outdoor storage handling and unloading area	20	LED Luminaire
(n)	Cement stores	150	Industrial dust proof type LED Luminaire
(o)	Chemical stores/House	150	Corrosion proof LED Luminaire



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	(p)	Permanent stores	150	LED high/medium bay / Industrial trough LED Luminaire
	(q)	Workshop. Building	150	LED high/medium bay / Industrial trough LED Luminaire
	(r)	Laboratory		
		General	150	Corrosion proof LED Luminaire
		Analysis area	300	
	(s)	Garage/Car Parking	50	Industrial type LED Luminaire
	(u)	AIS Switchyard and Substation	20(general 50(on strategic equipment)	LED Luminaire
	(v)	Transfer points, Sheds, tunnels, bunker house, Crusher house, Conveyor Gallery etc. in bidders scope	100	LED Dust tight/Well glass type Luminaire
	(w)	Facility building, canteen etc	150	Industrial type LED Luminaire
	(x)	Hydrogen Plant Building	150	Explosion proof HPMV/ Flourcent fittings suitable for class-I and Division –IIC
	(y)	DC Lighting- Control room	-	In candescent down light fixtures, Decorative recessed type with cylindrical reflector
	(z)	DC Lighting- Other Area	-	Incandescent Industrial Bulkhead
	(aa)	Corridors, Walkways	50	LED Luminaire
	(ab)	Building Periphery Lighting	10	LED Street Light fixture/ LED Luminaire
	(ac)	Security Lighting along Boundary	10	LED Street Light fixture/ LED Luminaire
	(ad)	ESP platform	150	LED well glass fixtures
	(ae)	Gate complex/Time Office	150	LED Luminaire
	(af)	GIS Hall	150	LED medium bay/ Luminaire
	(n)	DM plant, water treatment plant CW Pump house, Raw water PH, Fire Water PH	150	LED high/medium bay / Industrial trough LED Luminaire
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ANNEXURE-B

Sl.	Plant Areas	Normal AC Lighting System	Emergency AC Lighting System	220 V DC Lighting System	Portable DC Fixtures
1	TG Building(turbine hall, switchgear room etc)	80%	20%	√	—
2.	Boiler Platform	80%	20%	√	
3	DG Area/ Room	80%	20%		
4	Compressor Room				√
5	ESP Control Room	80%	20%		√
6	Unit Control Room	70%	30%		
7	Switchyard Control Room	80%	20%		
8	Battery Room	80%	20%		
9	Cable Spreader Room/ Vault	80%	20%	√	
10	Make Up Water Pump House	100%			√
11	Chemical House	100%			√
12	Fuel Oil Pump House	100%			√
13	Ash Handling Plant	100%			√
14	Water Treatment Plant	100%			√
15	CT Switchgear Room	100%			√
16	Cooling Towers	100%			
17	Workshop	100%			√
18	Service Building	100%			
19	Area Lighting	100%			
20	Street Lighting	100%			
21	Transformer Yard and Storage Yard	100%			
22	Coal Handling Plant	100%		√	
23	GIS Hall	80%	20%		
24	AIS Switchyard	80%	20%		



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	DC Emergency Lighting:			
		Area	Average Lux Level	
	1	Unit Control Room	100	
	2	Control Equipment Room	100	
	3	Switchyard Control Room	20	
	4	Strategic Control Points (In TG Building & Boiler Area, Switchgear room, SWAS, Battery Room, UPS Area, TG Hall, Luboil Room etc	20	
	5	Cable Vault & Galleries	1 fixture at every 20 metres spacing along walkways	
	6	Boiler Stair Case	1 fixture at every 20 metres spacing along walkways	
	7	Exit/ Entry of Main Plant Building	1 fixture	
	8	Fire Exit Sign	1 fixture	
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