

NTPC Limited

(A Government of India Enterprise)



SECTION – VI TECHNICAL SPECIFICATIONS FOR DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH

BIDDING DOCUMENT NO: CS-5714-004-(R)-9

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A-1) PROJECT INFORMATION				
	1.0	INTRODUCTION		
	<p>NTPC Ltd is a premier Maharatna public sector undertaking in the field of power generation. It has an installed capacity of 44,598 MW comprising of 40 plants with pan India presence. Govt. of Madhya Pradesh has agreed to give NTPC approximately 500 hectares of revenue land in Mandsaur district.</p> <p>250 MW solar power project shall be implemented in a single EPC package under domestic competitive bidding using domestically manufactured PV modules and cells.</p> <p>This EPC package is proposed to be awarded to multiple bidders in single/multiple blocks of 50 MW each with suitable award criteria to be intimated separately in the bidding documents.</p> <p>Accordingly this specification is for the development of a single solar block of 50 MW capacities.</p>			
2.0	LOCATION AND APPROACH			
		District	Mandsaur, Madhya Pradesh	
		Nearest Commercial Airport	Udaipur	
3.0	LAND AVAILABILITY			
		Land Availability (in Acres)	<p>Approx</p> <p>500 hectares of land in Mandsaur district.</p> <p>Land available for 250 MW(5 x 50 MW) SPV project and the demarcation of plot plan for 5X50 MW Solar PV blocks shall be furnished later.</p>	
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4.0	PROJECT CAPACITY			
	Name of the project		250 MW Solar Power Project(s) in Mandsaur district of Madhya Pradesh	
	Project capacity		250 MWp (DC capacity) Solar PV Project (To be awarded to multiple bidders in single/multiple blocks of 50 MW each.)	
	Technology		Solar PV Technology with Crystalline Silicon cells.	
5.0	TECHNOLOGY			
	In Solar Photo Voltaic Power Generation the direct conversion of solar radiation into electricity is achieved by using semiconductor devices “Solar Cells” which work on the principles of photo electric effect.			
6.0	POWER EVACUATION SYSTEM			
	The scope of power evacuation system in the scope of the bidder is upto the terminal point as indicated in the tender drawing no 5714-004-POE-A-006 Rev A. The Bidder shall be responsible for terminating their 33 kV evacuation feeder near 50MW block boundary at power evacuation point as decided by Employer.			
7.0	GENERATION GUARANTEE			
	The bidder shall guarantee net 83.735 MUs yearly generation at Export Bus (Ex Bus) at 33 kV outgoing feeder from respective 50 MW solar power block.(Refer details given in PG test chapter E-6).			
8.0	OTHER DETAILS			
	SLNO	ITEM	DETAILS	
	01	Water Requirement during construction	To be arranged by bidder	
	02	Power Requirement during construction	To be arranged by bidder	
	03	MOEF Clearance	Not Applicable	
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	04	SPCB Clearance	To be arranged by NTPC	
	05	MNRE Clearance	To be facilitated by bidder	
	06	Chief Electrical Inspector clearance	To be facilitated by bidder	
	07	Tree cutting permission	To be facilitated by bidder	
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CLAUSE NO.	<div> TECHNICAL SPECIFICATIONS </div> <div>  </div>		
1.0	<div> <h2>A-2) SCOPE OF SUPPLY AND SERVICES</h2> </div> <div> <h3>INTENT OF SPECIFICATION</h3> </div> <div> <p>The scope of the proposal for the Design Engineering, Supply, Construction, Erection, Testing, Commissioning including five year Operation and Maintenance (O&M) works for 50 MW Solar PV plant in Mandsaur district of Madhya Pradesh shall be on turnkey basis completely covering the following activities and services in respect of all the equipment & works specified and covered under the specifications and read in conjunction with “Scope of Supply & services” elaborated elsewhere.</p> </div> <div> <p>All equipment, materials and services whether explicitly stated or otherwise and that are necessary for the satisfactory operation of the Solar PV system and its integration with evacuation system provided by State Electricity Authority(s) shall be deemed to be included in the scope of work of the Contractor and shall not be limited to the following.</p> </div> <div> <ul style="list-style-type: none"> • Basic Engineering of the plant and systems. • Detailed design of all the equipment and equipment system(s) including civil works. • Providing, Review and approval of engineering drawings, data, process Calculations, test procedures, structural design calculations, Equipment layout, Drawings/Data sheets of bought out items, Civil structural/architectural Drawings, Performance & Guarantee Test procedure etc. • Providing Operation & Maintenance/ instruction manuals, as built drawings and other information; • Providing training of Employer’s personnel • Finalization of sub-vendors, manufacturing quality plans and Field quality plans. • Complete manufacturing including conducting all type, routine and acceptance tests; Civil, Structural and Architectural works to the extent applicable, including construction facilities and construction power distribution. </div>		
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1.1	<ul style="list-style-type: none">• Packing and transportation from the manufacturer's works to the site including customs clearance & port clearance, port charges, (if any).• Receipt, storage, preservation and conservation of equipment at the site; Fabrication, pre-assembly, (if any), erection, testing, pre-commissioning and commissioning and putting into satisfactory operation all the equipment including successful completion of initial operation• Reliability and Functional guarantee tests after successful completion of trial operation;• Supply of spares.• Satisfactory completion of the contract.• Special tools and tackles if any required for maintenance of the plant.			
	<p>The work to be carried out as per the above scope shall be all in accordance with the requirements, conditions, appendices etc. given in Technical Specifications (Section-VI) together with those stated in other Sections/Sub-sections of Bid Documents which shall be considered as a part of this volumes completely as if bound herewith. It is not the intent to specify herein all aspects of design and construction nevertheless, the equipments and civil works shall conforming all aspects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Employer, who will interpret the meaning of the specification and drawings and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable Indian / International standards mentioned elsewhere in this specification. The Bidder shall be responsible for providing all materials, equipment and services, specified or otherwise (unless specifically excluded) which are required to fulfill the intent of ensuring operability and the reliability of the complete system covered under this specification.</p>			
1.2	<p>Bidders are requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. Such clarifications should be sought within the time period as stipulated in section ITB. Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. However, if the bidder feels that, in his opinion, certain features brought out</p>			
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1.3	<p>in his offer are superior to what has been specified, these may be highlighted separately.</p> <p>The Bidder shall be responsible for providing all material, equipment and services, specified or otherwise which are required to fulfill the intent of specification and ensuring operability, maintainability and the reliability of the complete work covered under this specification.</p>			
1.4	<p>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 completion of the works as per schedule. Contractor shall be responsible for removing all deficiencies and supplying the equipment that meet the requirement.</p>			
1.5	<p>Before submitting his bid, the bidder should inspect and examine the site and its surroundings and should satisfy himself as to the nature of the ground and subsoil, the quantities and nature of work, materials necessary for completion of the work and their availability, means of access to site and in general shall himself obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect his offer. No consequent extra claims on any misunderstanding or otherwise shall be allowed by the Employer.</p>			
2.0.	<p>SCOPE OF WORK</p> <p>The detailed scope of work in accordance with this specification is elaborated below. The scope of the contractor shall be deemed to include all such items which although are not specifically mentioned in the bid documents and/or in contractor's proposal but are needed to make the system complete in all respects for its safe, reliable, efficient and trouble free operation and the same shall be furnished and erected unless otherwise specifically excluded as per Section Terminal Points & Exclusions.</p> <p>The Bidder shall also jointly facilitate in resolution of Land Acquisition issues related to the Project. Any due payments arising out of the Land Acquisition process shall however be paid by NTPC to the appropriate Authorities.</p>			
2.1	<p>ENGINEERING</p> <p>Detailed design of Grid Interactive Solar PV Plant and its associated civil, electrical & mechanical auxiliary systems includes preparation of foundation drawings, single line diagrams, installation drawings, electrical</p>			
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2.2	layouts, design calculations etc. Design memorandum and other relevant drawings and documents required for engineering of all facilities within the scope to be provided under this contract, are covered under contractors scope of work.			
	SUPPLIES & ASSOCIATED WORKS			
	DC SIDE			
	1.	Solar PV Modules		
	2.	Solar PV Modules Mounting Structure(MMS) along with foundation bolts		
	3.	DC Cables including MC4 connectors and DWC pipes		
	4.	String Monitoring Unit		
	5.	Power Conditioning unit		
	AC SIDE			
	6.	HT Switchgear		
	7.	LT Switchgear		
	8.	Inverter Transformer, Auxiliary Transformer		
	9.	HT Cables		
	10.	LT Cables		
	11.	SCADA		
	12.	Communication cable		
	13.	Earthing System		
	14.	Lightning Protection System		
	15.	Plant illumination system		
	16.	Auxillary Power Supply System		
	17.	Battery and Battery Charger		
	18.	UPS		
	19.	Time Synchronization Equipment		
	20.	CCTV		
21.	Metering System			
22.	Grid interfacing so as to meet statutory requirements			
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2.3			and comply to CERC code. All required hardware (AI & DI),Gateway Modem etc required for extending data to Regional Load Dispatch Centre(RLDC)/SLDC		
	23.	33 kV Switchyard Equipments			
	GENERAL SYSTEMS				
	24.	Weather Monitoring Station			
	25.	Fire Detection and protection system			
	26.	Module Washing system			
	CIVIL WORKS				
	Geotechnical investigation & Topography survey at site				
	Site Preparation : Site grading including slope protection, ground preparation/ filling/ levelling (if required) of the identified area and cutting , clearing and transporting of bushes/ vegetation/ trees etc.				
	Foundation :Requisite foundation and structures wherever required				
Rooms : Construction of Control room, Inverter room, security room, Gate complex.					
Cable Routing : Requisite cable routing through cable trenches/ trestle and/ or cable tray, Where ever required.					
Roads & Pathways : Construction of Main , service roads and pathways					
Drains : Design and construction of storm water drainage system.					
Fencing: Fencing along the periphery of the complete land					
2.4	OPERATION AND MAINTENANCE (O&M)				
	Comprehensive O&M of the solar PV plant (s) for a period of five (5) years from the date of successful completion of trial run is in the scope of the bidder.				
2.5	TRAINING OF EMPLOYERS PERSONNEL				
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2.6	<p>The bidder shall provide training free of cost to the personnel of NTPC for 50 man-days at his works and at site for erection, testing, commissioning and O&M. Expenses towards travel, lodging, and boarding and other expenses for the personnel shall be borne by NTPC.</p>			
	<p>TESTING</p> <p>During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification. Unless specified, the type test should have conducted 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 applicable period 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> <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>			
	2.7	<p>PAINTING</p> <p>The bidder's scope of work includes painting of all equipments and structures as per the Employer's standard colour coding scheme. The painting shall include required application of finish paint indicated elsewhere in the Technical Specification. The quality and finish of paints shall be as per standards of BIS or approved equivalent. Employer's Colour Coding scheme shall be furnished during detailed engineering stage.</p>		
		2.8	<p>PERFORMANCE GUARANTEE (PG) TEST</p> <p>The performance guarantee tests shall be carried out as specified elsewhere in the Technical Specification. All special equipment, tools and tackles instruments, measuring devices required for the successful conductance of PG test shall be provided by the bidder, free of cost. All costs associated with the PG tests shall be included in bid price.</p>	
2.9	<p>APPROVALS</p>			
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2.10	<p>The scope of the bidder includes complete design and engineering, technical coordination(including participation and arranging technical co-ordination meetings),finalization of drawings/ documents, submission of engineering drawing / documents and processing of their approvals by the Employer as per relevant clauses of Section VI (Technical Specifications) and other relevant clauses given elsewhere in the Technical Specifications. Further, the scope shall also include submission, in proper shape & format, of all types of manuals, handbooks & documents in requisite numbers to the Employer at different phases of the project as per the requirement of Employer. The contractor shall have to arrange technical coordination meetings and ensure participation</p>			
	<p>CODES AND STANDARDS</p> <p>All works shall be carried out as per the standards/codes (IEC, IS etc) referred in the specification. All standards, specifications and codes of practice referred to 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 codes/standards referred the former shall prevail.</p> <p>Equipments complying with other internationally accepted standards such as BS,UL,DIN,VDE etc. will also be considered, if they ensure performance and constructional features equivalent or superior to standards listed in the specification. In such case the Bidder shall clearly indicate the standards adopted, furnish a copy in the English of the latest revisions in force as on date of opening of bid and shall clearly bring out salient features for comparison.</p>			
	<p>3.0</p> <p>TERMINAL POINT AND EXCLUSIONS</p> <p>The terminal point under the scope of this assignment shall be 33 kV outgoing feeder upto block boundary along with associated terminal gantry as indicated in the tender drawing no 5714-004-POE-A-006 Rev -A enclosed with this specification. Bidder shall furnish all relevant data required by the employer at interface points within schedule as agreed prior to award of contract.</p>			
	<p>4.0</p> <p>TENDER DRAWINGS</p> <p>The list of drawings listed in Part-I of the Technical Specification shall form part of the specification and shall supplement the requirements specified in these technical specifications. These drawings are preliminary drawings for bidding purpose only and subject to changes that may be necessary during the detailed engineering keeping the basic parameters as specified.</p>			
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5.0	Various parameters for building and other equipment specified in the tender drawing are the minimum required & any increase in these parameters if required to meet the system requirement shall be made by the Bidder without any additional cost implication to Employer.			
	SPARES The Bidder shall include in his scope of supply all the necessary Mandatory spares as described elsewhere in the specifications.			
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	A-3) PROVENESS				
	Proveness criteria				
	1.0	The bidder/his sub-vendor(s) is required to meet the Proveness criteria and/or qualification requirement for critical component and bought out item as per the criteria stipulated below:			
1.1	Solar PV Modules:				
	The bidder/his sub-vendor shall meet the requirement as stipulated in para (a) and (b) below for supply of Solar PV Modules:				
	a.	The bidder/his sub-vendor should have manufactured and supplied the Solar PV Modules of cumulative installed capacity of 1MWp using any rating of modules and any source of indigenous or imported PV cells in any one financial year.			
	b.	The bidder/his sub-vendor should have manufactured and supplied Solar PV Module built up using indigenous or imported PV Cells of power rating 200Wp or above which must have been in successful operation for at least six (6) months as on the date of techno-commercial bid opening.			
2.0	Engineering Firm:				
	If the bidder himself has not carried out the engineering of at least one (1) number of Solar PV Power Plant of capacity 10 MWp (minimum) which is in successful operation for the last six (6) months as on the date of techno-commercial bid opening, the bidder shall employ an Engineering Firm who has engineered at least one (1) number of Solar PV Power Plant of capacity 10 MWp (minimum) at single location which is in successful operation for the last six (6) months as on the date of techno-commercial bid opening. The scope of work of engineering for the above project by the Firm shall necessarily include the following:				
	i.	Selection and Sizing of:			
	a.	Inverter			
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<div style="text-align: center;"> <p>b. PV Modules</p> <p>c. DC Cables</p> <p>ii. Finalization of Plant Layout with shadow analysis</p> <p>iii. Energy Estimation</p> </div> <p>The Firm shall undertake at least the above scope of engineering for the proposed Solar PV Power Plant.</p> <p>Appendix for Proveness Criteria of Solar PV Modules</p> <p>A)</p> <p>LIST OF SOLAR PLANTS OF CUMULATIVE CAPACITY 1 MW FOR WHICH SOLAR PV MODULES HAVE BEEN SUPPLIED DURING ANY ONE FINANCIAL YEAR.</p> <p>NAME OF BIDDER/ SUB-CONTRACTOR</p> <table border="1"> <thead> <tr> <th>SLNO</th> <th>FINANCIAL YEAR</th> <th>PROJECT LOCATION , CAPACITY, NAME OF CLIENT</th> <th>DATE OF AWARD</th> <th>APPROX CONTRACT VALUE(Rs)</th> <th>KWp / MWp of MODULES SUPPLIED DURING THE FINANCIAL YEAR</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table> <p>B)</p> <p>LIST OF SOLAR PLANTS IN SUCCESSFUL OPERATION USING THE SUPPLIED PV MODULES OF 200 Wp or above USING INDIGENOUS OR IMPORTED CELLS.IN OPERATION FOR AT LEAST 6 MONTHS</p> <p>NAME OF BIDDER/ SUB-CONTRACTOR</p>	SLNO	FINANCIAL YEAR	PROJECT LOCATION , CAPACITY, NAME OF CLIENT	DATE OF AWARD	APPROX CONTRACT VALUE(Rs)	KWp / MWp of MODULES SUPPLIED DURING THE FINANCIAL YEAR																			<p>The Bidder/Sub-contractor should enclose client certificate/and/or copy of Letter of Award in respect of above</p>				
	SLNO	FINANCIAL YEAR	PROJECT LOCATION , CAPACITY, NAME OF CLIENT	DATE OF AWARD	APPROX CONTRACT VALUE(Rs)	KWp / MWp of MODULES SUPPLIED DURING THE FINANCIAL YEAR																							
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CLAUSE NO.	<div>  TECHNICAL SPECIFICATIONS </div>					
	SLN O	PROJECT LOCATIO N , CAPACITY , NAME OF CLIENT	DATE OF AWARD	APPROX CONTRACT VALUE	(>) 200 Wp MODULES SUPPLIED (Y/N)	DATE OF COMMISSION ING OF THE PROJECT
	<p>The Bidder/Sub-contractor should enclose client certificate/and/or Letter from TRANSCO/DISCOM in respect of above.</p>					
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH			TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9		PART-A	Page 20 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS			<div>एनटीपीसी NTPC</div>								
	<div>Appendix for Proveness Criteria of Engineering Firm</div>											
	<p>It is declared that the bidder has qualified as per clause of main QR and itself has not carried out the engineering of at least one (1) number of Solar PV Power Plant of capacity 10 MWp (minimum) which is in successful operation for the last six (6) months prior to the date of techno-commercial bid opening. Hence, the bidder has employed an Engineering Firm who has engineered at least one (1) number of Solar PV Power Plant of capacity 10 MWp (minimum) at single location which is in successful operation for the last six (6) months prior to the date of techno-commercial bid opening. The scope of work of engineering for the above project by the Firm includes the following:</p>											
	<div><div>i. Selection and Sizing of:</div><div><div>a. Inverter</div><div>b. PV Modules</div><div>c. DC Cables</div></div><div>ii. Finalization of Plant Layout with shadow analysis.</div><div>iii. Energy Estimation.</div></div>											
	<p>The Firm shall undertake at least the above scope of engineering for the proposed Solar PV Power Plant.</p>											
	<table><tr><td>(I)</td><td>Whether bidder has carried out out the engineering of at least one (1) number of Solar PV Power Plant of capacity 10 MWp (minimum) which is in successful operation for the last six (6) months prior to the date of techno-commercial bid opening ?</td><td>(Yes / No)</td></tr><tr><td>(II)</td><td>Whether bidder has employed Engineering firm? Note: Provide the copy of the LOA mentioning clearly the engagement of the Engineering firm and the scope of work for the Solar PV Project.</td><td>(Yes / No)</td></tr><tr><td>(III)</td><td>Engineering Firm Details:</td><td></td></tr></table>				(I)	Whether bidder has carried out out the engineering of at least one (1) number of Solar PV Power Plant of capacity 10 MWp (minimum) which is in successful operation for the last six (6) months prior to the date of techno-commercial bid opening ?	(Yes / No)	(II)	Whether bidder has employed Engineering firm? Note: Provide the copy of the LOA mentioning clearly the engagement of the Engineering firm and the scope of work for the Solar PV Project.	(Yes / No)	(III)	Engineering Firm Details:
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(III)	Engineering Firm Details:											
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A	Page 21 of 415								


CLAUSE NO.	<div style="text-align: right;">  </div> TECHNICAL SPECIFICATIONS		
	(A)	Name and Address of the Engineering firm engaged by the Bidder with contact details like name, designation, mobile and email	
	(B)	Name and Address of the reference Solar PV Power plant(s) engineered by Engineering firm Note: Certificate from the owner of the reference plant clearly indication the scope of services provided by the Engineering firm, MWp capacity of the Solar PV plant, Date of commissioning of the plant. In case Engineering firm is also the owner of the project Date of commissioning is to be provided by appropriate authority. This Certificate shall also mention that the plant is in successful operation for Months prior to the date of techno commercial bid opening	
	(C)	Capacity of the reference plant(s) in MWp	
	(D)	Date of commissioning of the reference Solar PV Power Plant(s)	
	(E)	Whether the reference plant(s) is/are in successful operation for the last six(6) months prior to the date of techno commercial bid opening?	(Yes / No)
	(F)	Whether the scope of the Engineering Firm in the above Solar PV Power plant includes : i. Selection and Sizing of: a. Inverter b. PV Modules c. DC Cables ii. Finalization of Plant Layout with shadow analysis. iii. Energy Estimation.	(Yes / No) (Yes / No) (Yes / No) (Yes / No) (Yes / No)
	(G)	Whether the Firm shall undertake at least the scope of engineering as in clause (F) above for the proposed Solar PV Power Plant?	(Yes / No)
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A <div style="text-align: right;">Page 22 of 415</div>


CLAUSE NO.	TECHNICAL SPECIFICATIONS			<div>एनटीपीसी NTPC</div>
	<div>PART-B</div> <div>DC SYSTEMS</div>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A	Page 23 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS																	
1.0	B-1) SOLAR PHOTOVOLTAIC (SPV) MODULES																	
	GENERAL																	
	<p>The Solar PV module comprises of PV cells connected in series combination to achieve the required module power output. PV cells directly produce DC power on receipt of solar irradiation. The PV cells in a module shall be protected by encapsulation between glass and back sheet. The glass shall be made of high transitivity and front surface shall give high encapsulation gain.</p> <p>The technical details of Solar PV Modules shall be as given below.</p> <table><tr><th>S.No.</th><th>Description</th><th>Details</th></tr><tr><td>1</td><td>Type of SPV Module</td><td>Crystalline Silicon</td></tr><tr><td>2</td><td>Peak Power rating of Module</td><td>Shall not be less than 240Wp</td></tr><tr><td>3</td><td>Module Efficiency</td><td>More than 14% at Standard Test Conditions</td></tr><tr><td>4</td><td>Fill Factor</td><td>0.7(Minimum)</td></tr></table>				S.No.	Description	Details	1	Type of SPV Module	Crystalline Silicon	2	Peak Power rating of Module	Shall not be less than 240Wp	3	Module Efficiency	More than 14% at Standard Test Conditions	4	Fill Factor
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2.0	CODES AND STANDARDS																	
	<p>The applicable codes and standards are as mentioned below</p> <table><tr><th>Codes</th><th>Description</th></tr><tr><td>IEC 61215 – Edition 2.0 2005-04</td><td>Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval</td></tr><tr><td>IEC 61730 – 1 Edition 1.2 2013-03</td><td>Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction</td></tr><tr><td>IEC 61730 – 2 Edition 1.0 2004-10</td><td>Photovoltaic (PV) module safety qualification – Part 2: Requirements for Testing</td></tr><tr><td>IEC 61701 – Edition 2.0 2011-12</td><td>Salt mist corrosion testing of photovoltaic (PV) modules</td></tr></table>				Codes	Description	IEC 61215 – Edition 2.0 2005-04	Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval	IEC 61730 – 1 Edition 1.2 2013-03	Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction	IEC 61730 – 2 Edition 1.0 2004-10	Photovoltaic (PV) module safety qualification – Part 2: Requirements for Testing	IEC 61701 – Edition 2.0 2011-12	Salt mist corrosion testing of photovoltaic (PV) modules				
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3.0	TECHNICAL REQUIREMENTS																	
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A	Page 24 of 415														


CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	<p>a. SPV module shall perform satisfactorily with ambient temperatures between -10°C & +60°C and shall withstand gust up to 150 Km/h on the surface of the panel.Each and every SPV module shall conform to above standards and no negative power tolerance shall be accepted. Each inverter shall use only one type (Make and Nominal rating) of modules.</p> <p>b. Module shall be made up of mono or poly-crystalline silicon cells. Only domestically manufactured PV module and domestically manufactured cells shall be used. All process steps and quality control measures involved in the manufacture of PV cells and modules starting from P-type (or N-type) wafers till final assembly of the PV cells into modules shall be performed at the works of PV manufacturers in India. The requisite P-type (or N-type) wafers and other raw materials can be imported.</p> <p>c. The interconnected cells shall be laminated in vacuum to withstand adverse environmental conditions.</p> <p>d. The module frame shall be made of corrosion resistant materials, preferably having aluminum anodized finish. The anodizing thickness shall be 15 micron or better.</p> <p>e. The minimum clearance between the lower edge of the modules and the developed ground level shall be 500 mm. All the panels shall have provision to adjust it at three optimum angular positions. The optimum angle shall be proposed by the bidder and finalized during detailed engineering.</p> <p>f. Module(s) shall be provided with bypass diode.</p> <p>g. The SPV module must conform to IEC 61215 and IEC 61730 Part I and Part II. For coastal sites the SPV module shall also conform to IEC 61701.</p> <p>h. Each Solar PV modules used in solar power plants/ systems must be warranted for their output peak watt capacity, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years from the completion of the trial run.</p> <p>i. The bidder shall provide the sample solar PV module electrical characteristics including current-voltage (I-V) performance curves and temperature coefficients of power, voltage and current</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A	Page 25 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS	<div>एनटीपीसी NTPC</div>		
4.0	<p>j. Each PV module deployed must use a Radio Frequency identification (RFID) tag for traceability. RFID shall be mandatorily placed inside the module laminate and must be able to withstand harsh environmental conditions during the module lifetime. One number RFID reader has to be supplied by the bidder which has to be compatible to read the data from the RFID Tag & download the data to Computer. All associated Software & Cables are to be provided along with the RFID reader. The following information must be mentioned in the RFID used on the each module</p> <ul style="list-style-type: none">i. Name of the manufacturer - PV moduleii. Name of the manufacturer - Solar Cellsiii. Month & year of the manufacture (separate for solar cells and modules)iv. Country of origin (separately for solar cells and module)v. I-V curve for the modulevi. Wattage, Im, Vm and FF for the modulevii. Unique Serial No. and Model No. of the moduleviii. Date and year of obtaining IEC PV module qualification certificateix. Name of the test lab issuing IEC certificatex. Other relevant information on traceability of solar cells and module as per ISO 9001. <p>k. Junction box of the module should be of high quality IP 65 or better rated fitted at the back side which should be weather proof and designed to be used with standard wiring or conduit connection. Each Junction Box contains Bypass Diode.</p> <p>l. Each module should have two 4 sq.mm stranded UV resistant cables as per of TUV specification 2 Pfg 1169/08.2007 and terminated with connectors adaptive to MC4 type connector directly. MC4 type connector should be TUV certified. The positive (+) terminal has a male connector while the negative (-) terminal has a female connector.</p> <p>m. White back sheet should be used in module.</p> <p>n. All the modules in the PV plant should be arranged in a way so as to minimize the mismatch losses.</p>			
	<p>NAME PLATE</p> <p>All individual modules shall be provided with Name Plate label at the back of module which shall provide the information given below for identification.</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A	Page 26 of 415

CLAUSE NO.		TECHNICAL SPECIFICATIONS			
5.0		<p>They shall be clearly visible and shall not be hidden by equipment wiring. Type of labels and fixing of labels shall be such that they are not likely to peel off/ fall off during the life of the panel.</p> <ul style="list-style-type: none">1. Manufacturer’s Name2. Model Number, Serial Number3. Overall Dimensions (W x L x D)4. Weight (kg)5. Maximum Power (P_{MAX}) , Voltage (V_{MP}), Current (I_{MP})6. Short Circuit Current (I_{SC}), Open Circuit Voltage (V_{OC})7. Main System Voltage8. Relevant standards, Certification lab. Name9. NTPC Logo on the top corner of the each Module (Design shall be provided to successful bidder during detail engineering)10. Warnings, if any			
		<p>TYPE TEST</p> <p>SPV modules must be tested and certified by any of the accredited certifying agencies according to above mentioned International Standards at clause 2.0 above and the type test reports shall be submitted for approval.</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9		PART-A	
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
B-2)	MODULE MOUNTING STRUCTURE (MMS)			
	1.0	GENERAL		
	The PV modules shall be mounted on metallic structures called Module Mounting Structures (MMS) having adequate strength and appropriate design, which can withstand the load of the modules and design wind pressure.			
2.0	CODES AND STANDARDS			
The applicable codes and standards are as mentioned below.				
	1	IS 875: Part 1 & 2	Code of practice for the design loads for buildings and structures-	
	2	IS 875: Part 3	Code of practice for the design loads for buildings and structures-Wind Loads	
	3	IS 800 : 2007	Code of practice for use of structural steel in general building construction	
	4	IS-4759	Hot-dip zinc coatings on structural steel and other allied products	
	5	IS 1868	Anodic Coatings on Aluminium and its Alloys	
3.0	TECHNICAL REQUIREMENTS			
a) Modules shall be mounted on non-corrosive support structures.				
o. All the panels shall have provision to adjust it at three optimum angular positions. The optimum angle shall be proposed by the bidder and finalized during detailed engineering.				
b) Mounting structures shall be designed to withstand the extreme weather conditions in the area. Design wind speed factors shall be as per IS: 875-III, however the minimum value of these factors shall be considered as K1 = 1.0, K2 = 1.0 & K3 = 1.0 for the design of MMS.				
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A	Page 28 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS	<div>एनटीपीसी NTPC</div>	
	<p>c) The structural material, corrosion protection and design, shall be as per Design Criteria for Module Mounting Structures (MMS) described elsewhere in this specification.</p> <p>d) The proposed foundation system for MMS shall be as per the geo technical investigation report.</p> <p>e) The design philosophy and the calculations for the MMS and the foundation system shall be submitted for prior approval of NTPC before commencement of construction.</p> <p>f) Further details related to structures and foundations has been mentioned in the chapter on civil works of this specifications.</p> <p>g) In case, String Monitoring Unit(SMU) is mounted on the Module Mounting structures , bidder to take into consideration the load of SMU during design of MMS. Further suitable supporting members for mounting the SMU on the MMS shall also be in the scope of the bidder.</p>		
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
1.0	B-3) DC CABLES			
	<p>The DC Cables in a solar PV plant are used in the following areas</p> <ul style="list-style-type: none">i. Interconnecting SPV modulesii. From SPV Modules upto String Monitoring Unit(SMU)iii. From SMU upto the Inverter. <p>DC CABLES (Interconnecting SPV MODULES and from SPV Modules TO SMU)</p> <p>Cables used for inter-connecting SPV modules as well as Modules to SMU's shall conform to the requirements of TUV specification 2 Pfg 1169/08.2007 or EN 50618 for DC cable for photovoltaic system.</p> <p>These cables shall meet the fire resistance requirement as per TUV specification 2 Pfg 1169/08.2007 and shall be electron beam cured.</p> <p>The Cables used for (+) ve and (–)ve shall have distinct color identification on outer sheeth of the cable preferably with identifiable line along the cable. Insulation of the cable shall have natural color without any color additive.</p> <p>In addition to manufacturer's identification on cables as per TUV, following marking shall also be provided over outer sheath.</p> <ul style="list-style-type: none">(a.) Cable size and voltage grade(b.) Word 'FRNC' at every 5 metre(c.) Sequential marking of length of the cable in metres at every one metre <p>The Printing shall be progressive, automatic, in line and marking shall be legible and indelible.</p> <p>Type test, routine, acceptance tests requirements for these cables shall be as per TUV specification 2 Pfg 1169/08.2007.Charges of routine and acceptance tests shall be deemed to be included in the cable price. Sampling for acceptance tests will be as per IS 7098.</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A	Page 30 of 415


CLAUSE NO.	TECHNICAL SPECIFICATIONS			<div>एनटीपीसी NTPC</div>																					
1.0	B-4) STRING MONITORING UNIT (SMU)																								
	GENERAL																								
	<p>String Monitoring Unit (SMU) is used in multi-string photovoltaic systems to combine the individual strings electrically and connect them to the Inverters. It shall have protection devices to protect the PV modules from current/voltage surges. SMU should be capable to monitor the string/sub-array currents, Array voltage and total current of all the strings connected to SMU. The Nos of Sub-array shall be restricted to two(02). SMU shall have provision to monitor all the above parameters and shall communicate and transfer the required data to the SCADA for remote monitoring purposes.</p>																								
2.0	CODES AND STANDARDS																								
	<table><tr><th>S NO.</th><th>CODES</th><th>DESCRIPTION</th></tr><tr><td>1</td><td>UL 94 V</td><td>Fire Resistant/ flammability</td></tr><tr><td>2</td><td>UL 746C</td><td>UV Resistant</td></tr><tr><td>3</td><td>IEC 62262</td><td>Mechanical Impact Resistance</td></tr><tr><td>4</td><td>IS 2147/IEC 60529</td><td>Enclosure Protection</td></tr><tr><td>5</td><td>IEC 61643-12</td><td>Surge Protection</td></tr><tr><td>6</td><td>IEC 62208</td><td>Enclosure for low voltage Switchgear and control gear assemblies</td></tr></table>				S NO.	CODES	DESCRIPTION	1	UL 94 V	Fire Resistant/ flammability	2	UL 746C	UV Resistant	3	IEC 62262	Mechanical Impact Resistance	4	IS 2147/IEC 60529	Enclosure Protection	5	IEC 61643-12	Surge Protection	6	IEC 62208	Enclosure for low voltage Switchgear and control gear assemblies
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6	IEC 62208	Enclosure for low voltage Switchgear and control gear assemblies																							
3.0	GENERAL REQUIREMENT																								
	<p>SMU shall be equipped (but not limited to) with the following</p>																								
	<div><div>i.</div><div>DC Disconnector to disconnect the PV strings from the Inverter for maintenance purpose.</div><div>ii.</div><div>String fuses (one for each string) to prevent the reverse current flow.</div></div>																								
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A	Page 32 of 415																					

CLAUSE NO.	TECHNICAL SPECIFICATIONS	<div>एनटीपीसी NTPC</div>	
	<div><div><div>iii. Surge Protection Devices for protection against surge currents and voltages.</div><div>iv. Current and Voltage measurement shall be shunt based sensors.</div><div>v. Other associated items like cable glands, lugs and items required for the protection and completeness of the system.</div><div>vi. Suitable communication link/ media /Interface to communicate the data to SCADA.</div><div>vii. The following parameters shall be available at SCADA for monitoring the health of the each PV string:<div><div>a. String(s) Current</div><div>b. Voltage of SMU</div><div>c. Total current of SMU</div><div>d. Total Power of SMU</div><div>e. Status of Disconnect Switches and MOVs</div></div></div></div></div>		
4.0	<div><div>DC SURGE PROTECTION DEVICES (SPD) for PV Solar application:</div><div>SPD shall consist of three Metal Oxide Varistors (MOV) type surge arrestors which shall be connected from positive and negative bus to earth. The discharge capability of the SPD shall be at least 10kA at 8/20 micro second wave as per IEC 61643-12. During earth fault and failure of MOV, the SPD shall safely disconnect the healthy system. SPD shall have thermal disconnect to interrupt the surge current arising from internal and external faults. In order to avoid the fire hazard due to possible DC arcing in the SPD due to operation of thermal disconnect, the SPD shall be able to extinguish the arc.</div></div>		
5.0	<div><div>STRING FUSES</div><div>In order to provide protection to all cables and modules, string fuses shall be provided in both positive and negative legs of the string cabling. However, in case of negative grounded inverters, string fuse shall be provided in positive leg only as per recommendation of inverter manufacturer. String fuses shall be of gPV category and dedicated to solar applications and conform to IEC 60269-6 or UL-2579 standards. String fuses should be so designed that it should protect the modules from reverse current overload.</div></div>		
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
6.0	<p>SMU ENCLOSURE</p> <p>SMU enclosure shall be made of polycarbonate/FRP. SMU Enclosure shall satisfy the following requirement</p> <ul style="list-style-type: none">i. The enclosure shall be fire retardant with self-extinguishing property and free from Halogen.ii. Degree of protection for enclosure shall be at least IP 65.iii. The enclosure shall be UV protected.iv. The mechanical impact resistance of enclosure shall be IK 07 or better.v. The size of the enclosure shall be designed in such a way that the temperature rise of the enclosure should not more than 30 deg C above the ambient temp of 50 deg C. The components mounted inside the SMU shall have higher temperature withstand capability and shall continuously operate under such conditions. Contractor shall furnish the design calculation for temperature rise for owner's approval.vi. In each SMU 5% spare terminals (along with cable glands) rounded off to next higher integer shall be provided to connect the PV strings.vii. All terminals blocks shall be rated for min 1000V and rated continuously to carry maximum expected current.viii. In case, SMU is proposed to be mounted on the MMS structure, the additional load of the SMU shall be considered for the design of structure.ix. All internal wiring shall be carried out with 1100V grade stranded copper wires. All internal wiring shall be securely supported, neatly arranged readily accessible and connected to component terminals and terminal blocks. Wire terminations shall be made with solder less crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS		
7.0	ends of each wire. Ferrules shall fit tightly on wires shall not fall off when the wire is disconnected from terminal blocks.		
	DC PLUG-IN CONNECTORS FOR FIELD CABLING		
	Cable connector to be used for connecting SPV modules and String monitoring boxes shall be In accordance with DIN EN 50521. Connector shall be of plug and socket design to be plugged together by hand but can be separated again using a tool only.		
	TECHNICAL REQUIRMENTS		
	Rated Current, IEC (90 °C)	30 A (4 MM ² , 6 MM ²)- 40 A(10 MM ²)	
	Rated Voltage	1000 Volts as per TUV	
	Connector Design	Snap-In locking Type	
	Protection Degree	IP67	
	Ambient Temperature	(-) 400 C to (+) 900 C	
	Protection/Safety Class	Class II	
	Contact material	Cu	
	Contact surface material	Ag	
	Contact resistance for plug connector	≤ 0.5 milli-ohms	
	Stripping length	10mm	
	Inflammability class acc. to UL 94	UL94-V0	
	Insulating Material	PPE / Noryl (PPE + PS material)	
	Certification	VDE/TUV, UL 6703	
	Pollution degree	3	
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	<div><div><div><div><div><div></div><div><div>एनटीपीसी</div><div>NTPC</div></div></div></div></div></div></div>
	<div><div><div><div><div><div></div><div><div>B-5) POWER CONDITIONING UNIT</div></div></div></div><div><div><div><div><div><div></div><div><div>Power Conditioning Unit (PCU) shall consist of inverter along with associated control & protection, filtering, measuring instruments and data logging devices. The PCU shall be designed to supply the three phase AC power to the grid. The power conditioning unit shall be capable to adjust the output voltage & frequency to suit the grid condition. Rating of each PCU shall not be less than 500 KVA and the combined KVA rating of all PCUs shall not be less than 50000 KVA at maximum operating temperature. Only indoor type PCU shall be accepted.</div></div></div></div></div></div></div></div></div></div>
1.0	<div><div><div><div><div><div></div><div><div>CODES AND STANDARDS</div></div></div></div><div><div><div><div><div><div></div><div><div>IEC-61683</div><div>Photovoltaic systems –Power conditioners – Procedure for measuring efficiency</div></div></div><div><div></div><div><div>IEC 61000</div><div>Emission/ Immunity requirement Harmonics</div></div></div><div><div></div><div><div>IEEE 519</div><div>Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems</div></div></div><div><div></div><div><div>IEC 60068</div><div>Environmental Testing</div></div></div><div><div></div><div><div>IEC 62116</div><div>Utility-interconnected photovoltaic inverters - Test procedure of islanding prevention measures</div></div></div><div><div></div><div><div>IEC 62109</div><div>Safety of power converters for use in photovoltaic power systems</div></div></div><div><div></div><div><div>EN 53030</div><div>Overall efficiency of grid connected photovoltaic inverters</div></div></div><div><div></div><div><div>BDEW 2008</div><div>Technical Guidelines for Generating plant connected to Medium voltage network</div></div></div></div></div></div></div></div></div></div>
2.0	<div><div><div><div><div><div></div><div><div>GENERAL REQUIREMENTS</div></div></div></div><div><div><div><div><div><div></div><div><div>1. PCU must have provision to be isolated from grid through Air Circuit Breakers which shall be inbuilt with the inverter or located in separate standalone panel.</div></div></div><div><div></div><div><div>2. PCU shall confirm to IEC 61000 or equivalent international standard for compliance to requirements for Electromagnetic compatibility and to IEC60068-2 or equivalent international standard for requirement of environmental testing.</div></div></div><div><div></div><div><div>3. The minimum euro efficiency of the PCU as per IEC 61683 shall be 97%. The bidder shall specify the conversion efficiency at following</div></div></div></div></div></div></div></div></div></div>
<div><div><div><div><div><div></div><div><div>DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH</div></div></div></div><div><div><div><div><div><div></div><div><div>TECHNICAL SPECIFICATION</div><div>BID DOC. NO: CS-5714-004(R)-9</div></div></div></div><div><div><div><div><div><div></div><div><div>PART-A</div></div></div></div></div></div></div></div></div></div></div></div></div>	
<div><div><div><div><div><div></div><div><div>Page</div><div>36 of 415</div></div></div></div></div></div></div>	

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	<p>load conditions i.e. 25%, 50%, 75% and 100% during detail engineering, which shall be confirmed by type test reports.</p> <p>4. The PCU shall remain connected to the grid as per Central Electricity Authority Technical (standards for connectivity to the grid) regulation 2007 with all latest amendments and its components shall be designed accordingly</p> <p>5. The PCU shall have protection against any sustained fault in the feeder line and against lightning discharge in the feeder line.</p> <p>6. The PCU shall also have the adequate protection against earth leakage faults.</p> <p>7. The incoming DC feeder of PCU shall have suitably rated isolators to allow safe start up and shut down of the system and its terminals should be shrouded. The DC feeder shall terminate in the fuse box through a suitable fuse rating. The PCU fuse box shall have one spare terminal with fuse and holder for the future use. The connection between the fuse box and inverter shall be through copper bus bars or copper cable.</p> <p>8. Internal Surge Protection Device (SPD) shall be provided in the PCU on DC and AC side. It shall consist of Metal Oxide Varister (MOV) type arrestors. The discharge capability of the SPD shall be at least 10kA at 8/20 micro second wave as per IEC 61643-12. During earth fault and failure of MOV, the SPD shall safely disconnect the healthy system. SPD shall have thermal disconnecter to interrupt the surge current arising from internal and external faults. In order to avoid the fire hazard due to possible DC arcing in the SPD due to operation of thermal disconnecter, the SPD shall extinguish the arc.</p> <p>9. The PCU should be designed for parallel operation through galvanic isolation. Solid state electronic devices shall be protected to ensure smooth functioning as well as ensure long life of the inverter.</p> <p>10.The PCU shall have anti-islanding protection as per IEC 62116 or equivalent international standard.</p> <p>11.In case of grid failure, the PCU shall be re-synchronized with grid after revival of power supply. Vendor to furnish the time taken by PCU to be re-synchronized after restoration of grid supply during detailed engineering.</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A	Page 37 of 415

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	<p>12.PCU shall also confirm to IEC 62109 or IEC 62103 or equivalent international standard for compliance to requirement for the design and manufacture of PCU for protection against electric shock, energy, fire, mechanical and other hazards.</p> <p>13.Control and read-out should be provided on the indicating panel integral to the Inverter. Display should be simple and show all the relevant parameter relating to PCU operational data and fault condition in form of front Panel meters / LED's or two line LCD Display. It shall include all important parameter such as DC input voltage, DC input current, AC output voltage, AC output current, AC output power, frequency etc and the same has to be made available to SCADA also.</p> <p>14.The PCU shall include appropriate self-protective and self-diagnostic feature to protect itself and the PV array from damage in the event of PCU component failure or from parameters beyond the PCU's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the PCU front panel to cause the PCU to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the PCU, including commutation failure, shall be cleared by the PCU protective devices.</p> <p>15.The Contractor shall ensure by carrying out all necessary studies that the PCU will not excite any resonant conditions in the system that may result in the islanded operation of PV plant and loss of generation. In case there is excitation of any resonant condition in the system during PV plant operation that may result in the islanding/tripping of the PV plant and affect the power transfer, it shall be the responsibility of contractor to rectify the design and carryout required modification in the equipment of his supply.</p> <p>16.In case external aux. power supply is required, standalone UPS shall be used to meet auxiliary power requirement of PCU, it shall have a backup storage capacity of 120 minutes. The batteries used for these UPS shall be tubular lead acid type.</p> <p>17.In view of large plant size, in order to have real time control over the total power exported to grid, PCUs shall have in built control feature for changing output power set point individually and simultaneously from CMCS through plant SCADA and PCU manufacturer's own proprietary software. Operator shall be able to limit the total power (Active and</p>		
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A
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3.0	Reactive) injected in the grid through manual intervention as and when required in view of grid security.								
	18.Bidder to provide the complete wiring diagram of PCU during detailed Engineering and during submission of O&M manual. Bidder also to provide its control board programing software with perennial license to the owner								
	OPERATING MODES OF PCU								
	<table><tr><td>i. LOW POWER MODE</td></tr><tr><td>The control system shall continuously monitor the output of the solar PV plant until pre-set value is exceeded and begins to export power provided there is sufficient solar energy and the grid voltage and frequency are in the specified range.</td></tr><tr><td>ii. ACTIVE Maximum Power Point Tracking(MPPT) MODE (HIGH POWER MODE):</td></tr><tr><td>When solar radiation increases further, the PCU shall enter Maximum Power Point Tracking (MPPT) mode and adjust the voltage of the SPV array to maximize solar energy fed into the grid. When the solar radiation falls below threshold level, the PCU shall enter in low power mode.</td></tr><tr><td>iii. SLEEP MODE</td></tr><tr><td>Automatic 'sleep' mode shall be provided so that unnecessary losses are minimized at night. Contractor shall provide threshold DC voltage level / power level of the PCU as to when it shall enter into the sleep mode and back to low power mode and MPPT during the detailed engineering for approval.</td></tr><tr><td>iv. LOW VOLTAGE MODE</td></tr><tr><td>The inverter shall be capable of operation under reduced power mode and shall not trip when the PV array output voltage is below MPPT range under high temperature conditions.</td></tr></table>	i. LOW POWER MODE	The control system shall continuously monitor the output of the solar PV plant until pre-set value is exceeded and begins to export power provided there is sufficient solar energy and the grid voltage and frequency are in the specified range.	ii. ACTIVE Maximum Power Point Tracking(MPPT) MODE (HIGH POWER MODE):	When solar radiation increases further, the PCU shall enter Maximum Power Point Tracking (MPPT) mode and adjust the voltage of the SPV array to maximize solar energy fed into the grid. When the solar radiation falls below threshold level, the PCU shall enter in low power mode.	iii. SLEEP MODE	Automatic 'sleep' mode shall be provided so that unnecessary losses are minimized at night. Contractor shall provide threshold DC voltage level / power level of the PCU as to when it shall enter into the sleep mode and back to low power mode and MPPT during the detailed engineering for approval.	iv. LOW VOLTAGE MODE	The inverter shall be capable of operation under reduced power mode and shall not trip when the PV array output voltage is below MPPT range under high temperature conditions.
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4.0	MAXIMUM POWER POINT TRACKING (MPPT)								
	Maximum Power Point Tracker (MPPT) shall be integrated in the power conditioning unit to maximize energy drawn from the Solar PV array. The MPPT should be microprocessor based to minimize power losses. The details of working mechanism of MPPT shall be submitted during the detail								
<table><tr><td>DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH</td><td>TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9</td><td>PART-A</td><td>Page 39 of 415</td></tr></table>		DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH	TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-A	Page 39 of 415				
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5.0	<p>engineering. The operating voltage range of PCU and the MPPT shall be large enough such that it satisfactorily operates for PV modules exposed to the maximum ambient temperature of 50⁰C.</p>																																
	<p>INVERTER</p>																																
	<p>The inverter output shall always follow the grid in terms of voltage and frequency. This shall be achieved by sensing the grid voltage and phase by the feedback control loop of the inverter and the inverter shall always remain synchronized with the grid. The inverter shall use only self-commutated device which shall be adequately rated. PCU shall be designed to deliver its nameplate rating at ambient temperature of 50°C. Bidder shall also furnish the rating at operating temperature of 25 °C during detailed engineering. The other technical details required are as under.</p>																																
	<table><tr><td>Nominal Frequency</td><td>Output</td><td>50Hz</td></tr><tr><td>Power Factor Range</td><td>Control</td><td>> = 0.95 lead or lag</td></tr><tr><td>Maximum Input voltage</td><td></td><td>1000 V DC</td></tr><tr><td>THD_i</td><td></td><td>Less than 4% at nominal load</td></tr><tr><td>Ambient temperature</td><td></td><td>0 to 50⁰ C</td></tr><tr><td>Humidity</td><td></td><td>95 % non-condensing</td></tr><tr><td>Enclosure</td><td></td><td>IP 20 (Minimum)</td></tr><tr><td>Maximum Noise Level</td><td></td><td>75 dBA</td></tr><tr><td>DC injection</td><td></td><td>Less than 0.5% of nominal load current</td></tr><tr><td>Flicker</td><td></td><td>As per IEC 61000</td></tr></table>			Nominal Frequency	Output	50Hz	Power Factor Range	Control	> = 0.95 lead or lag	Maximum Input voltage		1000 V DC	THD _i		Less than 4% at nominal load	Ambient temperature		0 to 50 ⁰ C	Humidity		95 % non-condensing	Enclosure		IP 20 (Minimum)	Maximum Noise Level		75 dBA	DC injection		Less than 0.5% of nominal load current	Flicker		As per IEC 61000
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<p>The Inverter shall also have following features:</p>																																	
<p>a. Maximum loss in sleep mode shall be less than 0.05% of rated power.</p>																																	
<p>b. Set point pre-selection for Active Power and VAR control</p>																																	
<p>c. Unit wise & integrated Data logging.</p>																																	
<p>d. Dedicated Modbus/Ethernet for networking</p>																																	
<p>e. Protection against</p>																																	
<ul style="list-style-type: none">• AC/DC Over current• Sync loss• Over temp.• AC/DC bus over voltage• Cooling system failure																																	
<p>f. Power regulation in the event of thermal overloading</p>																																	
<p>g. Bus communication for integration with SCADA</p>																																	
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	<p>h. Integrated protection in the DC and three phase system</p> <p>i. Insulation monitoring of the PV array with sequential fault location</p> <p>j. Ground fault detector to sense discharge current with respect to ground.</p> <p>k. The inverter shall be capable of operating in the frequency range of 47.5 Hz to 52 Hz and shall be able to deliver rated output in the frequency range of 49.5 Hz to 50.5 Hz. This performance shall be achieved with voltage variation of up to ± 5% subject to availability of solar insolation.</p> <p>The power conditioning unit must be self-managing and stable in operation. A self-diagnostic system check should occur on start up. Functions should include a test of key parameters on start up.</p>			
6.0	<p>EARTHING OF INVERTERS</p> <p>DC side of each inverter shall be earthed to distinct earth pit through adequate size conductor as per IS 3043-1987. The size of conductor shall be as per the maximum fault current of DC system.</p>			
7.0	<p>VENTILATION</p> <p>To prevent the maximum permissible temperature in the inverter room from being exceeded because of internal heat emission of inverters and other auxiliaries in the inverter room, the inverter room in the PV station shall be adequately ventilated.</p> <p>The Ventilation plant capacity and air quality of inverter room shall be as per inverter and other auxiliaries manufacturer’s recommendations. Filter banks at the air inlet of the inverter room shall be provided to prevent dust ingress.</p>			
8.0	<p>TYPE TESTING</p> <p>During detailed engineering, the contractor shall submit all the type test reports including temperature rise test and surge withstand test carried out within last ten years from the date of techno-commercial bid opening for Owner's approval. 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 techno-commercial bid opening, or in the case of type test report(s) are not found to be meeting</p>			
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	<p>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>		
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TECHNICAL SPECIFICATIONS

PART-C **AC SYSTEMS**

1.0

C-1) LT SWITCHGEAR

CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as published one month prior to the date of opening of bids. 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 codes and standards.

IS	Details
IS 5	Colors for ready-mixed paints and enamels.
IS 694	PVC insulated cables for working voltages upto and including 1100V.
IS 722	A.C. Electricity Meters
IS 1248	Electrical Indicating instruments
IS/IEC 60947-1	Degree of protection provided by enclosures for low voltage Switchgear and Control gear
IS/IEC 60947-2	A.C. circuit Breakers including MCCBs
IS 2551	Danger Notice Plates
IS 2629	Hot dip galvanising
IS 2705	Current Transformers
IS/IEC 60947-4-1	Contactors and motors starter for voltages not exceeding 1000 V AC or 1200 VDC
IS 3043	Code of practice for earthing.
IS 3072	Code of practice for installation and maintenance of Switchgear
IS 3156	Voltage Transformers
IS 3202	Code of practice for climate proofing of electrical equipment.
IS 3231	Electrical relays for power system protection.
IS/IEC 60947	Air-Break Switches, air break disconnectors, air break disconnector and fuse combination units for voltages not exceeding 1000V AC or 1200 V DC.

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IS/IEC 60947-1	General Requirements for Switchgear and Control gear for voltages not exceeding 1000 V.
IS 5082	Wrought Aluminum and Aluminum alloys for electrical purposes.
IS 6005	Code of practice of phosphating of iron and steel.
IS/IEC 60947-5-1	LV switchgear and Control gear Control current devices and switching element.
IS 8623 (3 parts) / IEC 61439-1&2	Specification for factory built assemblies of Switchgear & Control gear for voltages upto and including 1000 V AC & 1200 V DC.
IS 8686	Static Relays
IS 13703 / IEC 60269	HRC Cartridge fuses
IS 10118 (4 parts)	Code of practice for selection, installation and maintenance of switchgear and control gear.
IS 11171	Specification for dry type transformers.
IEC 60255	Electrical Relays
IEC 61850	Communication networks and systems in substations
IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals
IS 12021	Specification of control transformers for switchgear and Control gear for voltage not exceeding 1000V AC.
IEC 60947-7-1	Terminal blocks for copper conductors
IS 513 (2008)	Cold Rolled Low Carbon Steel Sheets and Strips

1.0

TECHNICAL PARAMETERS

2.1

Power Supply (AC SYSTEM)

1)	Voltage	415V \pm 10%, 3 Phase, 4 wire, Neutral Solidly Earthed
2)	Frequency	50 Hz \pm 5%
3)	Combined variation (in volts &	10% absolute sum

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TECHNICAL SPECIFICATIONS

2.2

	frequency)	
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CUBICLE DATA (Bus-bar Rating of Inverter Breaker)

1)	Continuous Current rating	As per requirement
2)	Short time rating where	
	a) Circuit Breaker (CB) is used as incomer	50kA (RMS) for one sec
	b) Fuse protection is used in Incomer	Prospective current of 50Ka (RMS) for the fuse clearing time
3)	Dynamic Rating where	
	a) CB is used as incomer	105kA (PEAK)
	b) Fuse Protection is used in incomer	Prospective current of 105kA (PEAK) as limited by fuse
4)	Busbar insulation	
	a) For switchgear	PVC Sleeve insulated

NOTE: For other switchgear, the bus requirement shall be as per system requirement.

2.3

CIRCUIT BREAKER

1)	Type	Air break spring charged stored energy type
2)	Operating duty	O-3min-OC-3min-OC
3)	Symmetrical interrupting	50kA (RMS)
4)	Short circuit rating	105kA (PEAK)
5)	Short Circuit Breaking current	

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TECHNICAL SPECIFICATIONS

2.4

METER

1)	Accuracy class	2.0
2)	One min. power frequency withstand test voltage	2.0kV (RMS)

2.5

DIGITAL MFM

1)	Accuracy class	0.5
2)	Voltage Ratio	415/110 V

2.6

CURRENT TRANSFORMERS

1)	Type	Cast Resin Bar Primary
2)	Voltage class and frequency	650V, 50HZ
3)	CT Secondary Current	1 A
4)	Class of insulation	E or better
5)	Accuracy class & burden	
	a) For Protection	5P20, 5VA PS Class for REF
	b) For Metering	Class 1.0, 5VA (min)
6)	Instrument Security Factor for metering CT	5
7)	Short time withstand	

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TECHNICAL SPECIFICATIONS

2.7

VOLTAGE TRANSFORMERS

1)	Type	Cast Resin
2)	Voltage Ratio	415 / 110V for line PT 415/ $\sqrt{3}$ / 110/ $\sqrt{3}$ V for Bus PT
3)	Method of Construction	Vee Vee
4)	Accuracy Class	0.5
5)	Rated Voltage factor	1.1 continuous, 1.5 for 30 sec.
6)	Class of insulation	E or better
7)	One minute power frequency withstand voltage	2.5 KV

2.8

HRC FUSES

1)	Voltage Class	650 Volts
2)	Rupturing capacity	80kA (RMS) for AC circuits 20kA for DC circuits

2.9

CONTACTORS

1)	Type	Air break electro magnetic
2)	Utilising Category	AC3 of IS/IEC 60947 for non reversible AC4 of

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TECHNICAL SPECIFICATIONS

2.10

RELAYS

		IS/IEC 60947 for reversible drives
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1) Power frequency withstand voltage

2.5kV for 1 sec. or 2.0kV for 1 min.

2.11

TRANSDUCERS

1)	Current transducers	
a)	Input	0-1 A (CT secondary)
b)	Rated frequency	50Hz
c)	Output	4-20mA (2 Nos. decoupled)
d)	Over current	Transducer for motor current ammeters shall be capable of withstanding min. 6 times CT sec. current of 1A for a min period of 30 seconds
e)	Accuracy	1.0
2)	Voltage Transducers	
a)	Input	110V (VT secondary), 50Hz (for AC) / 240V DC (for DC)
b)	Output	4-20mA (2 Nos. decoupled)
c)	Accuracy	1.0

2.12

MCCB

	Rated voltage	415V
	Rated Insulation Level	690V
	Rated ultimate and service SC breaking capacity(As per system requirement)	50kA
	Rated making capacity(As per system requirement)	105kA
	Utilization category	A

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3.0	<p>CONSTRUCTIONAL DETAILS OF INDOOR SWITCHBOARDS</p> <ol style="list-style-type: none"> Switchboards shall be of metal enclosed, indoor, floor-mounted, free-standing type. All switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. All panel edges and cover / door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members. The top covers of the panels should be designed such that they do not permanently bulge/ bend by the weight of maintenance personnel working on it. The switchboards shall be of bolted design. The complete structures shall be rigid, self-supporting, and free from flaws, twists and bends. All cutouts shall be true in shape and devoid of sharp edges. All switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 5X as per IS/IEC 60947. However, the busbar chambers having a degree of protection of IP: 42 are also acceptable where continuous busbar rating is 1600A and above. Provision shall be made in all compartments for providing IP: 5X degree of protection, when circuit - breaker or module trolley has been removed. All cutouts shall be provided with EPDM / Neoprene gaskets. Provision of louvers on switchboards would not be preferred. However, louvers backed with metal screen are acceptable on the busbar chambers where continuous busbar rating is 1600 A and above. All switchboards shall be of uniform height not exceeding 2450 mm. Switchboards shall be easily extendable on both sides by the addition of vertical sections after removing the end covers. Switchboards shall be supplied with base frames made of structural steel sections, along with all necessary mounting hardware required for welding down the base frame to the foundation / steel insert plates. The base frame height shall be such that floor finishing (50mm thick) to be done by Employer after erection of the switchboards does not obstruct the movement of doors, covers, with draw able modules etc. All switchboards shall be divided into distinct vertical sections (panels), 			
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	<p>each comprising of the following compartments:</p> <ul style="list-style-type: none"> i. Bus Bar Compartment A completely enclosed bus bar compartment shall be provided for the horizontal and vertical busbars. Bolted covers shall be provided for access to horizontal and vertical busbars and all joints for repair and maintenance, which shall be feasible without disturbing any feeder compartment. Auxiliary and power busbars shall be in separate compartments. ii. Switchgear/Feeder Compartment All equipment associated with an incomer or outgoing feeder shall be housed in a separate compartment of the vertical section. Two-tier breaker arrangement in a vertical section shall be offered for outgoing breaker feeders of rating up to 1600A. The design of the vertical section for such an arrangement shall ensure ease of termination of power cables of size & quantity as per relevant clause of specification. The compartment shall be sheet steel enclosed on all sides with the withdrawable units in position or removed. Insulating sheet at rear of the compartment is also acceptable. The front of the compartment shall be provided with the hinged single leaf door with captive screws for positive closure. iii. Cable Compartment/ Cable Alley A full-height vertical cable alley of minimum 250mm width shall be provided for power and control cables. Cable alley shall have no exposed live parts and shall have no communication with busbar compartment. Cable terminations located in cable alley of capacity more than 63 A shall be designed to meet the Form IVb (as per IEC 61439-1) for safety purpose. Wherever cable alleys are not provided for distribution boards, segregated cable boxes for individual feeders shall be provided at the rear for direct termination of cables. For circuit breaker external cable connections, a separately enclosed cable compartment shall also be acceptable. The contractor shall furnish suitable plugs to cover the cable openings in the partition between feeder compartment and cable alley. Cable alley door shall be hinged. iv. Control compartment(if applicable) A separate compartment shall be provided for relays and other control devices associated with a circuit breaker. 			
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	<p>11. Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. EPDM / Neoprene gasket shall be provided between the panel sections to avoid ingress of dust into panels.</p> <p>12. After isolation of power and control circuit connections it shall be possible to safely carryout maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose. Wherever two breaker compartments are provided in the same vertical section insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on the other circuit.</p> <p>13. All 415V switchgear (circuit-breaker) panels shall be of single-front type. DBs shall be of single-front / double-front construction as per requirement. All single-front switch boards shall be provided with single-leaf, hinged or bolted covers at the rear. The bolts shall be of captive type. The covers shall be provided with "DANGER" labels. All panel doors shall open by 90 deg or more. In case of double-front MCCs, if this cannot be achieved for panels adjacent to a breaker panel, suitable dummy panel shall be provided by the Bidder wherever necessary.</p> <p>14. All 415V circuit-breaker modules shall be of fully draw out type having distinct 'Service' and 'Test' positions. The equipment pertaining to a draw out type incomer or feeder module shall be mounted on a fully withdrawable chassis which can be drawn out without having to unscrew any wire or cable connection. Suitable arrangement with cradle / rollers, guides along with tool / lever operated racking in / out mechanism shall be provided for smooth and effortless movement of the chassis. For modules of size more than half the panel height, double guides shall be provided for smooth removal or insertion of module. All identical module chassis of same size shall be fully interchangeable without having to carry out any modifications. Suitable interlock shall be provided in DCDBs for prevention of opening of Isolator (Incomer) when the bus coupler is open and vice-versa.</p> <p>15. All disconnecting contacts for power and control circuits of draw out modules shall be of robust and proven design, fully self-aligning and spring-loaded. Both fixed and moving contacts shall be silver-plated and replaceable. The spring-loaded power and control drawout contacts shall be on withdrawable chassis and the same on fixed portion shall not be accepted. Detachable plug and socket type control terminals shall also be acceptable.</p> <p>16. Individual opening in the vertical bus enclosure shall permit the entry of</p>			
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4.0	<p>moving contacts from the draw out modules into vertical droppers.</p> <p>17. All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to employer's approval. The Contractor shall submit dimensional drawings showing complete internal details of bus bars and module components, for each type and rating for approval of Employer.</p> <p>18. The tentative power and control cable entry shall be from bottom. However, the Employer reserves the right to alter the cable entries, if required during detailed engineering, without any additional commercial implication.</p> <p>19. Each switchboard shall be provided with undrilled, removable type gland plate, which shall cover the entire cable alley. Bidder shall ensure that sufficient cable glanding space is available for all the cables coming in a particular section through gland plate. For all single core cables, gland plate shall be of non-magnetic material. The gland plate shall preferably be provided in two distinct parts for the easy of terminating addition cables in future. The gland plate shall be provided with gasket to ensure enclosure protection. Recommended drilling chart of gland plates for all power and control cables in the vertical panels shall be indicated by the Contractor in the respective G.A. drawings of the boards.</p> <p>20. The Bidder shall consider layout of panels in a switchboard consisting of various feeder modules as per system requirement in a straight line, unless specified otherwise. The actual composition and disposition of various modules in a switchboard shall be finalised during detailed engineering. The Bidder shall include in his quoted price the cost of any adopter panel / dummy panel required to meet various configuration / arrangement of busbars adopted by the Bidder.</p> <p>21. The minimum clearance in air between phases and between phases and earth for the entire run of horizontal and vertical busbars and bus-link connections at circuit-breaker shall be 25mm. For all other components, the clearance between "two live parts", "a live part and an earthed part", shall be at least ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for horizontal and vertical busbars the clearances specified above should be maintained even when the busbars are sleeved or insulated. All connections from the busbars up to switch / fuses shall be fully insulated and securely bolted to minimize the risk of phase to phase and phase to earth short circuits.</p> <p>POWER BUSBARS AND INSULATORS</p> <p>1. All switchboards shall be provided with three phase and neutral</p>			
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5.0	<p>busbars. Two separate sets of vertical busbars shall be provided in each panel of double front DBs. Interleaving arrangement for busbars shall be adopted for switchboards with a rating of more than 1600A. DCDBs shall be provided with two (2) busbars. Entire busbar system shall be insulated with PVC sleeves. Busbar sleeves shall be compliant to UL224 (Extruded insulating tubing), CE/UL certified, having fire retardant properties and working temperature of 1050C.</p> <ol style="list-style-type: none"> All busbars and jumper connections shall be of high conductivity aluminum alloy / copper of adequate size. The cross-section of the busbars shall be uniform throughout the length of switchboard section and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents. Neutral busbar short circuit strength shall be same as main busbars. All busbars shall be adequately supported by non-hygroscopic, non-combustible, track-resistant and high strength sheet molded compound or equivalent type polyester fiber glass molded insulator. Separate supports shall be provided for each phase and neutral busbar. If a common support is provided, anti-tracking barriers shall be provided between the supports. Insulator and barriers of inflammable material such as Hylam shall not be accepted. The busbar insulators shall be supported on the main structure. All busbar joints shall be provided with high tensile steel bolts, belleville / spring washers and nuts, so as to ensure good contacts at the joints. Non-silver plated busbar joints shall be thoroughly cleaned at the jointed locations and suitable contact grease shall be applied just before making a joint. All bolts shall be tightened by torque spanner to the recommended value. The overlap of the busbars at each joint surface shall be such that the length of overlap shall be equal to or greater than the width of the busbar. All copper to aluminum joints shall be provided with suitable bimetallic washers. All busbars shall be colour coded as per IS: 375. Wherever the busbars are painted with black Matt paint, the same should be suitable for temperature encountered in the switchboard under normal operating conditions. The Bidder shall furnish calculations establishing the adequacy of bus bar sizes for specified current ratings. 			
	<p>AUXILIARY SUPPLY SYSTEM</p> <p>1. CONTROL SUPPLY</p> <p>Electrically controlled circuit breaker boards shall be provided with DC control supply busbars. The manually controlled breakers shall also be</p>			
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6.0	<p>provided with such busbars in case relays are provided. Each section of the switchboard shall be provided with a DC supply. Suitable terminals, switch-fuse etc. shall be provided to receive the DC supply and distribute the same through above mentioned control busbars to the required modules of the respective section. The DC control supply bus of one section shall be coupled to the control supply of other section through a switch located in the bus-coupler breaker panel. The DC supply to the bus-coupler breaker may be given from any of the control buses.</p> <p>2. SPACE HEATER</p> <p>Panel space heaters shall be fed from separate AC auxiliary busbars running throughout the switchboard. The supply for these busbars shall be tapped from incomer, before the isolating switch/ circuit breaker. Incoming circuit to space-heater bus shall have an isolating switch, HRC fuse and neutral link of suitable rating. Panel illumination and plug-socket shall also be tapped from the space heater busbars. Suitable terminals shall also be provided to facilitate energisation of space-heater bus from outside during long shutdowns of switch-board.</p>			
	<p>EARTH BUS AND EARTHING</p> <ol style="list-style-type: none"> 1. A galvanized steel / Copper / Aluminium earth bus shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded / bolted to the framework of each panel and breaker earthing contact bar. Vertical earth bus shall be provided in each vertical section which shall in turn be bolted / welded to main horizontal earth bus. 2. The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current to earth, as indicated in "Technical Parameters", without exceeding the allowable temperature rise. 3. Suitable arrangements shall be provided at each end of the horizontal earth bus for bolting to earthing conductors. The horizontal earth bus shall project out of the switchboard ends and shall have predrilled holes for this connection. All joint splices to earth bus shall be made through at least two bolts, and taps by proper lug and bolt connection. 4. All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosure framework and truck shall be maintained even after painting. 5. The carriage and breaker frame shall get earthed while being inserted in the panel and positive earthing of the breaker frame shall be 			
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7.0	<p>maintained in all positions, i.e. SERVICE & ISOLATED, as well as throughout the intermediate travel.</p> <ol style="list-style-type: none"> Each module frame shall get engaged to the vertical earth bus before the disconnecting contacts on the module are engaged to the vertical busbars. All metallic cases of relays, instruments and other panel-mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. All the equipment mounted on the door shall be earthed through flexible wire/braids. Insulation color code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors, soldering is not acceptable. Looping of earth connections, which would result in loss of earth connections to other devices, when a device is removed, is not acceptable. However, looping of earth connections between equipment to provide alternative paths to earth bus is acceptable. VT and CT secondary neutral point earthing shall be at one place only, i.e. on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit. All hinged doors having potential carrying equipment mounted on it shall be earthed by flexible wire/ braid. For doors not having potential carrying equipment mounted on it, earth continuity through scraping hinges/ hinge pins of proven design may also acceptable. The Contractor shall establish earth continuity at site also. 			
	<p>CIRCUIT BREAKERS</p> <p>Circuit breakers shall be three pole, air break, horizontal draw out type, and shall have fault making and breaking capacities as specified in "Technical Parameters". The circuit breakers which meet specified parameters of continuous current rating and fault making / breaking capacity only after provision of cooling fans or special device shall not be acceptable.</p> <ol style="list-style-type: none"> Circuit breakers along with its operating mechanism shall be provided with suitable arrangement for easy withdrawal. Suitable guides shall be provided to minimize misalignment of the breaker. There shall be "SERVICE", "TEST" and "FULLY WITHDRAWN" positions for the breakers. In "Test" position the circuit breaker shall be capable of being tested for operation without energising the power circuits i.e. the power contacts shall be disconnected, while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the "SERVICE", "TEST" or "FULLLY WITHDRAWN" position. Circuit Breaker rack-in and rack-out from Service to Test, Test to Isolated position, or vice-versa 			
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	<p>shall be possible only in the compartment door closed condition.</p> <ol style="list-style-type: none"> 3. All circuit breakers shall be provided with "6 NO" and "6 NC" potential free auxiliary contacts. The contacts dedicated for the Employer's use shall be made to operate only in breaker service position condition. These contacts shall be in addition to those required, for internal mechanism of the breaker and should be directly operated from breaker operating mechanism. Separate limit switches, each having required numbers of contacts shall be provided in both "SERVICE" and "TEST" position of the breaker. All contacts shall be rated for making, continuously carrying and breaking 10 Amp at 240 V AC and 1 Amp (Inductive) at 240 V DC respectively. 4. Suitable mechanical indications shall be provided on all circuit breakers to show "OPEN", "CLOSE", "SERVICE ", "TEST" AND "SPRING CHARGED" positions. 5. Main poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half a cycle of rated frequency. 6. All circuit breakers shall be provided with the following interlocks: 7. Movement of a circuit breaker between "SERVICE" and "TEST" position shall not be possible unless it is in open position. Attempted withdrawal of a closed circuit breaker shall preferably not trip the circuit breaker. In case the offered circuit breaker trips on attempted withdrawal as a standard interlock, it shall be ensured that sufficient contact exists between the fixed and drawout contact at the time of breaker trip so that no arcing takes place even with the breaker carrying its full rated current. 8. Closing of a circuit breaker shall not be possible unless it is in "SERVICE" position, "TEST" position or in "FULLY WITHDRAWN" position. 9. Circuit-breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage, to cover the stationary isolated contacts when the breaker is withdrawn. It shall however be possible to open the shutters intentionally against pressure for testing purposes. 10. Breaker of particular rating shall be prevented from insertion in a cubicle of a different rating. 11. Circuit breakers shall be provided with coded key / electrical interlocking devices, as per requirements. 12. Circuit breaker shall be provided with anti-pumping feature and trip free feature, even if mechanical anti-pumping feature is provided. 13. Mechanical tripping shall be possible by means of front mounted Red "trip" push-button. In case of electrically operated breakers these push 			
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buttons shall be shrouded to prevent accidental operation.

14. Complete shrouding / segregation shall be provided between incoming and outgoing bus links of breakers. In case of bus coupler breaker panels the busbar connection to and from the breaker terminals shall be segregated such that each connection can be approached and maintained independently with the other bus section live. Dummy panels if required to achieve the above feature shall be included in the Bidder's scope of supply.

15. Circuit breaker shall be provided with Power operated mechanism as follows.

1.	Power operated mechanism shall be provided with a Universal motor suitable for operation on 230 V AC / 220 V DC/110 VDC Control supply. In case of DC supply motor should satisfactorily operate with voltage variation between 187V - 242V /93.5-121 V DC. Motor insulation shall be class "E" or better.
2.	The motor shall be such that it requires not more than 30 seconds for fully charging the closing spring at minimum available control voltage.
3.	Once the closing springs are discharged, after one closing operation of circuit breaker, it shall automatically initiate recharging of the spring.
4.	The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible
5.	Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.
6.	All circuit breakers shall be provided with closing and trip coils. The closing coil shall operate correctly at all values of voltage between 187V - 242V /93.5-121 V DC. The trip coil shall operate satisfactorily at all values of voltage between 154V - 242V DC/77-121V DC.
7.	Provision for mechanical closing of the breaker only in "Test" and "WITHDRAWN" positions shall be made. Alternately, the mechanical closing facility shall be normally made inaccessible; accessibility being rendered only after deliberate removal of shrouds.

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| 8. | The ACB Panel door shall not be possible to open in breaker closed condition. Further, the racking mechanism shall be accessible only after opening the breaker panel door. |
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16. Telescopic Trolley

Telescopic trolley or suitable arrangement shall be provided for maintenance of circuit-breaker module in a cubicle at each location. The trolley shall be such that the top most breaker module can be withdrawn on the trolley and can be lowered for maintenance purpose. The telescopic trolley shall be such that all type, size and rating of breaker can be withdrawn /inserted of particular switchgear.

8.0

AIR BREAK SWITCHES

1. Air break switches shall be of heavy duty, single throw, group operated, load break, fault make type when associated with fuses. All switches for motor circuits shall be of utilisation category AC-23A with 1NO +1NC auxiliary contact. All switches for other outgoing feeders shall be of utilization category AC-22A. All switches for DC circuits shall be suitable for 240 V DC and shall be of DC-22 utilisation category.
2. Continuous current rating of the switches shall be selected as per the requirements considering all specified ambient conditions
3. The combination of switch-fuse unit would be preferred. However, if separate switch and fuses are provided, switch shall be located before fuses.
4. The main switches shall be operable from outside the module door. The switch handle shall clearly indicate the position of switch. Switch operating handles shall be provided with padlocking facilities. However, incomer switches of switchboards shall be provided with padlocking facility in both 'ON' and 'OFF' positions.
5. Interlocks shall be provided such that the cubicle door will not open when the switch is in closed position and the switch will close only when the door is closed. However, suitable means shall be provided to intentionally defeat these interlocks.
6. Switches and fuses for AC/DC control supply and heater supply wherever required, shall be mounted inside the cubicles. Toggle switch is not acceptable.

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11.0	<p>characteristics. Switch rating shall in no case be less than the fuse rating.</p> <p>5. The Neutral links shall be mounted on fuse carriers which shall be mounted on fuse bases.</p>			
	<p>INTERNAL WIRING</p> <ol style="list-style-type: none"> All switchboards shall be supplied completely wired internally upto the terminals, ready to receive external cables. All intercubicle and interpanel wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided by the Bidder. All auxiliary wiring shall be carried out with 650V grade, single core stranded copper conductor, colour coded, PVC insulated wires. Conductor size shall be 1.5 mm² (min.) for control circuit wiring and 2.5 mm² (min) for CT and space heater circuits. Extra flexible wires shall be used for wiring to devices mounted on moving parts such as hinged doors. The wire bunches from the panel inside to the doors shall be properly sleeved or taped. All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminal blocks. All internal wiring terminations shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor or an equally secure method. Similar lugs shall also be provided at both ends of component to component wiring. Insulating sleeves shall be provided over the exposed parts of lugs to the extent possible. Screw-less (spring loaded) / cage clamp type terminal shall also be provided with lugs. Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS: 375. Red Ferrules should be provided on trip circuit wiring. Wiring for equipment, which are to be supplied by the Employer and for which the Contractor has to provide mounting arrangement in his panels, shall also be provided by the Contractor, upto the terminal blocks. All connections from vertical busbars for individual modules above 100 A shall be by Copper / Aluminum links only. The cable connections for modules less than 100 A shall be selected in such a way that there will not be any melting / shorting in case of a short circuit inside the module and the cable shall have current rating to carry the let through energy of 			
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12.0	<p>the corresponding fuses in case of a fault. The insulation of the cable and its cross section shall be decided considering the high ambient temperature within the module. For all modules where use of cable is envisaged by the Contractor specific approval from the Employer regarding cable details are to be taken. For power wiring colour coded wire insulation / tapes shall be provided.</p>			
	<p>POWER CABLE TERMINATION</p> <ol style="list-style-type: none"> 1. Cable termination compartment and arrangement for power cables shall be suitable for heavy duty, 1.1 kV grade, stranded aluminum conductor, PVC/ XLPE insulated, armoured / unarmoured and PVC sheathed cables. All necessary cable terminating accessories such as supporting clamps and brackets, hardware etc., shall be provided by the contractor, to suit the final cable sizes. 2. All power cable terminals shall be of stud type and the power cable lugs shall be of tinned copper solderless crimping ring type conforming to IS: 8309. All lugs shall be insulated/ sleeved. 			
13.0	<p>NAME PLATES AND LABELS</p> <ol style="list-style-type: none"> 1. All Switchgears, MCCs, Distribution Boards, Fuse boards, all feeders, local push-button stations and local motor starters shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear switchgear also. 2. All name plates shall be of non-rusting metal or 3-ply Lamicoid, with white engraved lettering on black background. Inscription & lettering sizes shall be subject to Employer's approval. 3. Suitable stenciled paint mark shall be provided inside the panel/module for identification of all equipment in addition to the plastic sticker labels, if provided. These labels shall be positioned so as to be clearly visible and shall have the device number. 4. Caution name plate "Caution Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end. 			
	<p>PAINTING</p> <p>All sheet steel work shall be pretreated, in tanks, in accordance with IS: 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall</p>			
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<p>15.0</p> <p>16.0</p> <p>17.0</p>	<p>be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS: 6005. The phosphated surfaces shall be rinsed and passivated. After passivation, Electrostatic Powder Coating shall be used. Powder should meet requirements of IS 13871 (Powder costing specification). Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the Employer. The paint thickness shall not be less than 50 microns. Finished parts shall be suitably packed and wrapped with protective covering to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.</p> <p>GASKETS</p> <p>The gaskets, wherever specified, shall be of good quality EPDM / Neoprene with good ageing, compression and oil resistance characteristics suitable for panel applications.</p> <p>TEMPERATURE-RISE (For LT Switch-gear having capacity more than 400A)</p> <p>The temperature rise of the horizontal and vertical busbars and main bus links including all power draw out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg C with silver plated joints and 40 deg C with all other types of joints over an outside ambient temperature of 50 deg C. The temperature rise of the accessible parts/external enclosures expected to be touched in normal operation shall not exceed 20deg. C. The temperature rise of manual operating means shall not exceed 10deg. C for metallic & 15 deg. C for insulating material. Temperature rise for the busbars shall be carried out at 90% of the rated current.</p> <p>DERATING OF COMPONENTS</p> <p>The Bidder shall, ensure that the equipment offered will carry the required load current at site ambient conditions specified and perform the operating duties without exceeding the permissible temperature as per Indian Standards / Specification. Continuous current rating at 50 deg C ambient in no case shall be less than 90% of the normal rating specified.</p> <p>The Bidder shall indicate clearly the derating factors if any employed for each component and furnish the basis for arriving at these derating factors</p>			
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18.0	<p>duly considering the specified current ratings and ambient temperature of 50 deg C.</p> <p>PROTECTION CO-ORDINATION</p> <p>It shall be the responsibility of the Contractor to fully coordinate the overload and short circuit breakers/fuses with the upstream and downstream circuit breakers / fuses, to provide satisfactory discrimination. Further, the various equipments supplied shall meet the requirements of Type II class of Co-ordination as per IS: 8544.</p>			
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1.0
C-2) HT SWITCHGEAR
CODES AND STANDARDS

All standards, specification and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of Techno commercial 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 and codes

One No of Spare 33 kV breaker panel need to be provided at the HT bus feeding 132 kV transformer.

Sl no	IS code	Name of equipment
a)	IS: 722	AC electricity meters.
b)	IS: 996	Single phase small AC and universal electrical motors.
c)	IS: 1248	Direct Acting indicating analogue electrical measuring instruments and Accessories.
d)	IS: 13947	Degree of protection provided by enclosures for low voltage switchgear and control gear.
e)	IS: 2544	Porcelain post insulators for systems with nominal voltages greater than 1000 Volts.
f)	IS: 2705	Current transformers.
g)	IS: 3156	Voltage Transformers
h)	IS: 6005	Code of practice for phosphating of iron and steel.
j)	IS: 5082	Specification for wrought aluminium and aluminium alloy bars, rods, tubes and selections for electrical purposes.
k)	IEC: 61850	Communication Standard for Numerical relays
l)	IEC: 61131-3	Automation Standard for Numerical relays
m)	IS: 9046	AC contactors for voltages above 1000 volts and upto and including 11000 Volts.
n)	IS: 13703	Low voltage fuses

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o)	IS: 9385	HV fuses
p)	IS: 9431	Specification for indoor post insulators of organic material for system with nominal voltages greater than 1000 volts upto and including 300 kV
q)	IS: 9921	A.C. disconnectors (isolators) and Earthing switches for voltages above 1000 V
r)	IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
s)	IS: 13118	Specification for high voltage AC circuit breakers.
t)	IEC: 60099-4	Metal oxide surge arrester without gap for AC system
u)	IS/IEC: 62271-100	High voltage alternating current circuit breakers.
v)	IS/IEC: 62271-200	High voltage metal enclosed switchgear and control gear.
w)	IEC: 60947-7-1	Terminal blocks for copper conductors
(x)	IS :513 (2008)	Cold Rolled Low Carbon Steel Sheets and Strips

2.0

TECHNICAL PARAMETERS

i) SYSTEM PARAMETERS

1	Nominal System voltage	33kV
2	Highest System voltage	36kV
3	Rated Frequency	50Hz
4	Number of phases/ poles	Three
5	System neutral earthing	Solidly Earthed
6	One minute power frequency withstand voltage	

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	- for Type tests		70kV
	- for Routine tests		70kV
7	1.2/50 microsecond Impulse withstand voltage		170kV (peak)
8	Minimum system fault level		25 kA (rms)*
9	Short time rating for bus bars, ckt. breakers, current transformers and swgr. Assembly.		25 kA (rms)* for one (1) sec.
10	Dynamic withstand rating		63.5 kA (Peak)
11	Control supply voltage		220V DC/110V DC unearthed
	- Space heaters	240 V AC single phase with neutral solidly earthed	
12	Maximum ambient air temperature	50 deg. C	

* 12.5 kA or system requirement which ever is higher

ii) BUS BARS

1.	Continuous current rating at 50°C ambient:	As Per Requirement
2.	Temper Rise allowed above ambient	40°C for plain joints 55°C for Silver plated joints

iii) SWGR. CUBICLE CONSTRUCTIONAL REQUIREMENTS

1.	Colour finish			
	Exterior	RAL9002 (Main body) RAL 5012 (Extreme end covers)		
2.	Cable entry			
	a)	Power Cables	Bottom	
	b)	Control Cables	Bottom	
3	Earthing conductor	Galvanized steel strip		

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4	Service Continuity of swgrs(LSC2B-PM)	as per IS/IEC 62271-200
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iv) CIRCUIT BREAKERS

1.	The circuit breakers current rating shall be selected from the load current given in SLD which is at an ambient of 50 deg. C.	
2.	Short circuit breaker Current	33kV
	a) A.C. component	25 kA or system requirement which ever is higher
	b) D.C. component	As per IS: 13118 or IEC-62271
3.	Short Circuit making current	2.5 times of system fault current (peak)
4.	Operating Duty	O-3 Min-CO-3 Min-CO
5.	Total break time	Not more than 4 cycles
6.	Total make time	Not more than 5 cycles
7.	Operating Mechanism	Motor wound spring charged stored energy type as per IEC-62271

v) CURRENT TRANSFORMER

1.	Secondary Current	1A
2.	Class of Insulation	Class E or better
3.	Rated output of each	Adequate for the relays and devices connected, but not less than five (5) VA.
4.	Accuracy class	
	Protection	Class PS for Differential & REF and Core Balance CTs (CBCT); 5P20 for other protection CTs;
	Measurement	0.2s
5.	Minimum primary earth fault current to be detected by CBCT	3 Amperes
6.	Instrument Security Factor for Measurement CTs	5

vi) VOLTAGE TRANSFORMERS		
1	Rated Voltage Factor	2 continuous for all VTs
2.	Class of insulation	Class E or better
3.	Other parameters	BUS PT-0.5 Class, VA req. adequate for application. Line PT-0.5 Class for sync. / 3P for door interlocks & protection, VA req. adequate for application.

3.0
SWITCHGEAR PANEL

- i. The switchgear boards shall have a single front, single tier, fully compartmentalized, metal enclosed construction complying with clause No. 3.102 of IEC 62271-200, comprising of a row of free standing floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker truck, cable termination, main busbars and auxiliary control devices. The adjacent panels shall be completely separated by steel / Aluzinc sheets except in bus bar compartments where insulated barriers shall be provided to segregate adjacent panels. The Service Class Continuity of Switchgears shall be LSC 2B-PM (as per IS/ IEC 622771-200). However, manufacturer's standard switchgear designs without inter panel barriers in busbar compartment may also be considered.
- ii. The circuit breakers and bus VTs shall be mounted on withdrawable trucks which shall roll out horizontally from service position to isolated position. For complete withdrawal from the panel, the truck shall rollout on the floor or shall roll out on telescopic rails. In case the later arrangement is offered, suitable trolley shall be provided by the Bidder for withdrawal and insertion of the truck from and into the panel at each location (switchgear room. Testing of the breaker shall be possible in Isolated position by keeping the control plug connected.
- iii. The trucks shall have distinct SERVICE and ISOLATED positions. It shall be possible to close the breaker compartment door in isolated position also, so that the switchgear retains its specified degree of protection. Circuit Breaker rack-in and rack-out from Service to Test, Test to Isolated position, or vice-versa shall be possible only in the compartment door closed condition. While switchboard designs with doors for breaker compartments would be preferred, standard designs of reputed switchgear manufacturers where the truck front serves as

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	<p>the compartment cover may also be considered provided the breaker compartment is completely sealed from all other compartments and retains the IP-4X degree of protection in the Isolated position. In case the latter arrangement is offered, the Bidder shall explain how this sealing is achieved and shall include blanking covers one for each size of panel per switchboard in his total Techno commercial bid price.</p> <p>iv. The switchgear assembly shall be dust, moisture, rodent and vermin proof, with the truck in any position SERVICE, ISOLATED or removed, and all doors and covers closed. All doors, removable covers and glass windows shall have gaskets all round with synthetic rubber or neoprene gaskets.</p> <p>v. The control/ relay compartments shall have degree of protection not less than IP 5X in accordance with IS/IEC 60947. However, remaining compartments can have a degree of protection of IP 4X. All louvers, if provided, shall have very fine brass or GI mesh screen. Tight fitting gaskets / gaskets are to be provided at all openings in relay compartment. Numerical Relays shall be fully Flush mounted on the switchgear panels at a suitable height.</p> <p>vi. The switchgear construction shall be such that the operating personnel are not endangered by breaker operation and internal `explosions, and the front of the panels shall be specially designed to withstand these. Pressure relief device shall be provided in each high voltage compartment of a panel, so that in case of a fault in a compartment, the gases produced are safely vented out, thereby minimizing the possibility of its spreading to other compartments and panels. The pressure relief device shall not however reduce the degree of protection of panels under normal working conditions. To demonstrate that the pressure relief device operates satisfactorily the Contractor shall submit a type test report in line with IEC 62271-200 Annex - A, for each high voltage chamber.</p> <p>vii. Enclosure shall be constructed with rolled steel / Aluzinc sections. The doors and covers shall be constructed from cold rolled steel sheets of 2.0 mm or higher thickness. Gland plates shall be 2.5 mm thick made out of hot rolled or cold rolled steel sheets and for non-magnetic material it shall be 3.0 mm.</p> <p>viii. The switchgear shall be cooled by natural air flow.</p> <p>ix. Total height of the switchgear panels shall not exceed 2600mm. The height of switches, pushbuttons and other hand operated devices shall not exceed 1800mm and shall not be less than 700mm.</p> <p>x. Necessary guide channels shall be provided in the breaker compartments for proper alignment of plug and socket contacts when truck is being moved to SERVICE position. A crank or lever arrangement shall preferably be provided for smooth and positive</p>			
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4.0	<p>movement of truck between Service and Isolated positions.</p> <ul style="list-style-type: none"> xi. Safety shutters complying with IEC 62271-200 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to ISOLATED position. The shutters shall move automatically, through a linkage with the movement of the truck. Preferably it shall however, be possible to open the shutters of busbar side and cable side individually against spring pressure for testing purpose after defeating the interlock with truck movement deliberately. In case, insulating shutters are provided, these shall meet the requirements of IEC 62271-200 and necessary tests as per IEC 62271-200 Clause 5.103.3.3 shall be carried out. A clearly visible warning label "Isolate elsewhere before earthing" shall be provided on the shutters of incoming and tie connections which could be energized from other end. xii. Switchgear construction shall have a bushing or other sealing arrangement between the circuit breaker compartment and the busbar / cable compartments, so that there is no air communication around the isolating contacts in the shutter area with the truck in service position. xiii. The breaker and the auxiliary compartments provided on the front side shall have strong hinged doors. Busbar and cabling compartments provided on the rear side shall have separate bolted covers with self retaining bolts for easy maintenance and safety. Breaker compartment doors shall be provided with single-shot latch type handle and shall have locking facility. Suitable interlock shall be provided, which will ensure that breaker is OFF before opening the back doors. Suitable interlock shall be provided to prevent opening of any compartment doors which has any of the MV equipment, in case the supply is ON. xiv. In the Service position, the truck shall be so secured that it is not displaced by short circuit forces. Busbars, jumpers and other components of the switchgear shall also be properly supported to withstand all possible short circuit forces corresponding to the short circuit rating specified. xv. Suitable base frames made out of steel channels shall be supplied along with necessary anchor bolts and other hardware, for mounting of the switchgear panels. These shall be dispatched in advance so that they may be installed and leveled when the flooring is being done, welding of base frame to the insert plates as per approved installation drawings shall be in Bidder's scope. <p>CIRCUIT BREAKERS</p> <ul style="list-style-type: none"> a. The circuit breakers shall be of Vacuum type. 			
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	<p>b. They shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism.</p> <p>c. Circuit breaker shall be restrike free, stored energy operated and trip free type. Motor wound closing spring charging shall only be acceptable. An anti-pumping relay shall be provided for each breaker, even if it has built-in mechanical anti-pumping features. An arrangement of two breakers in parallel to meet a specified current rating shall not be acceptable.</p> <p>d. During closing, main poles shall not rebound objectionably and mechanism shall not require adjustments. Necessary dampers shall be provided to withstand the impact at the end of opening stroke.</p> <p>e. Plug and socket isolating Contacts for main power circuit shall be silver plated, of self-aligning type, of robust design and capable of withstanding the specified short circuit currents. They shall preferably be shrouded with an insulating material. Plug and socket contacts for auxiliary circuits shall also be silver plated, sturdy and of self-aligning type having a high degree of reliability. Thickness of silver plating shall not be less than 10 microns.</p> <p>f. All working part of the mechanism shall be of corrosion resisting material. Bearings which require greasing shall be equipped with pressure type grease fittings. Bearing pins, bolts, nuts and other parts shall be adequately secured and locked to prevent loosening or change in adjustment due to repeated operation of the breaker and the mechanism.</p> <p>g. The operating mechanism shall be such that failure of any auxiliary spring shall not prevent tripping and shall not lead to closing or tripping of circuit breaker. Failure of any auxiliary spring shall also not cause damage to the circuit breaker or endanger the operator.</p> <p>h. Mechanical indicators shall be provided on the breaker trucks to indicate OPEN / CLOSED conditions of the circuit breaker, and CHARGED / DISCHARGED conditions of the closing spring. An operation counter shall also be provided. These shall be visible without opening the breaker compartment door.</p> <p>i. The rated control supply voltage shall be as mentioned elsewhere under Technical parameters. The closing coil and spring charging motor shall operate satisfactorily at all values of control supply voltage between 187V-242V/93.5V-121V DC. The shunt trip coil shall operate satisfactorily under all operating conditions of the</p>		
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5.0	<p>circuit breaker upto its rated short circuit breaking current at all values of control supply voltage between 154V-242V/77V-121V DC. The trip coil shall be so designed that it does not get energized when its healthiness is monitored by two indicating lamps (Red) and one trip coil supervision relay.</p> <p>j. The time taken for charging of closing spring shall not exceed 30 seconds. The spring charging shall take place automatically preferably after a closing operation. Breaker operation shall be independent of the spring charging motor which shall only charge the closing spring. Opening spring shall get charged automatically during closing operation. As long as power supply is available to the charging motor a continuous sequence of closing and opening operations shall be possible. One open-close- open operation of the circuit breaker shall be possible after failure of power supply to the motor. Spring charging motors shall be capable of starting and charging the closing spring twice in quick succession without exceeding acceptable winding temperature when the control supply voltage is anywhere between 187V-242V DC. The initial temperature shall be as prevalent in the switchgear panel during full load operation with 50 deg. C ambient air temperature. The motor shall be provided with short circuit protection.</p> <p>k. Motor windings shall be provided with class E insulation or better. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in a hot, humid and tropical climate.</p> <p>l. Circuit breaker shall be provided with inter pole barriers of insulating materials. The use of inflammable materials like Hylam shall not be acceptable.</p>			
	<p>CONTROLS AND INTERLOCKS</p> <ul style="list-style-type: none"> ▪ The circuit breaker will normally be controlled from remote control panels through closing and shunt trip coils. The Local control console of the relay flush mounted on the switchgear would normally be used only for testing of circuit breaker in isolated position, and for tripping it in an emergency. The closing and opening of the breaker shall also be possible from the Laptop through front serial port of the relay to facilitate commissioning activities. ▪ The basic control scheme shall be developed in the numerical relay using programmable (soft) logics. ▪ Facilities shall be provided for mechanical tripping of the breaker and for manual charging of the stored energy mechanism for a complete duty cycle, in an emergency in closed door condition. 			
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6.0	<ul style="list-style-type: none"> ▪ Each panel shall have two separate limit switches, one for the Service position and the other for isolated position. Each of these limit switches shall have at least four (4) contacts which shall close in the respective positions. ▪ Auxiliary Contacts of breaker may be mounted in the fixed portion or in the withdrawable truck as per the standard practice of the manufacturer, and shall be directly operated by the breaker operating mechanism. ▪ Auxiliary contacts mounted in the fixed portion shall not be operable by the operating mechanism, once the truck is withdrawn from the service position, but remain in the position corresponding to breaker open position. Auxiliary contacts mounted on the truck portion, and dedicated for Employer's use shall be wired out in series with a contact denoting breaker service position. With truck withdrawn, the auxiliary contacts shall be operable by hand for testing. There shall be at least 6 NO and 6 NC breaker/contactors original Auxiliary contacts made available for the use of the Employer. ▪ The contacts of all limit switches and all breaker auxiliary contacts located on truck portion and fixed portion shall be silver plated, rated to make, carry and break 1.0A 240V DC (Inductive) / 10A 240V AC. Contacts of control plug and socket shall be capable of carrying the above current continuously. ▪ Movement of truck between SERVICE and ISOLATED positions shall be mechanically prevented when the breaker is closed. An attempt to withdraw a closed breaker shall not trip it. ▪ Closing of the breaker shall be possible only when truck is either in ISOLATED or in SERVICE position and shall not be possible when truck is in between. Further, closing shall be possible only when the auxiliary circuits to breaker truck have been connected up, and closing spring is fully charged. ▪ It shall be possible to easily insert breaker of one typical rating into any one of the panels meant for same rating but at the same time shall be prevented from inserting it into panels meant for a different type or rating. ▪ Indications shall be provided in the relay console flush mounted on the panel front as brought out in the specification elsewhere. It shall be possible to easily make out whether the truck is in SERVICE OR ISOLATED POSITION even when the compartment door is closed. <p>NUMERICAL RELAYS AND NETWORKING</p>			
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	<ul style="list-style-type: none"> ▪ All circuit breaker feeders shall be provided with communicable numerical relays (IED, i.e. Intelligent Electronic Device) complying with IEC-61850, having protection, control, measurement and monitoring features. These relays shall be networked and suitably interfaced with the Solar SCADA system for dynamic SLD display, status monitoring, measurements, event / alarm displays, reports, etc. The relays shall be flush mounted on panel front with connections from the inside. These numerical relays shall be of types as proven for the application and shall be subject to Employer's approval. Numerical relays shall have appropriate setting ranges, accuracy, resetting ratio and other characteristics to provide required sensitivity. All equipments shall have necessary protections. ▪ The numerical relay shall be capable of measuring and storing values of a wide range of quantities, events, faults and disturbance recordings. The alarm / status of each of protection function and trip operation shall be communicated to Solar SCADA. The numerical relays shall have built in feature / hardware interface to provide such inputs to Solar SCADA for analog / digital values. ▪ All relays shall be rated for control supply voltage as mentioned elsewhere under parameters and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Contacts for breaker close and trip commands shall be so rated as to be used directly used in the closing and tripping circuits of breaker without the need of any interposing / master trip relays. Threshold voltage for binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages and typically shall be more than 70% of the rated control supply voltage. ▪ One minute power frequency withstand test voltage for all numerical relays shall at least be 2kV (rms). ▪ Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker operation. ▪ Disturbance Record waveforms, event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data. ▪ All numerical relays shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts as per the requirement of control schematics. The quantities of such input / outputs shall be finalized during detailed engineering. ▪ All the numerical relays shall have communications on two ports, local front port communication to laptop and rear port on IEC 61850 to communicate with the interface equipment for connectivity with the 			
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	<p>Solar SCADA. Latest version of hardware and Software for interfacing the numerical relays with laptop has also to be provided.</p> <ul style="list-style-type: none"> ▪ All the numerical relays shall have adequate processor memory for implementing the programmable scheme logic required for the realization of the protection / control schemes, in addition to the built in protection algorithms. ▪ All Numerical relays shall have features for electrical measurements including voltage, current, power (active & reactive), frequency, power-factor and energy parameters. ▪ Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping. ▪ Master trip (86) and non-86 trips shall be software configurable to output contacts and no separate master trip relay shall be used. ▪ All numerical relays shall have provision of both current and voltage inputs. Relays shall be suitable for both residually connected CT input as well as CBCT input. Number of CT inputs shall be adequate for protections detailed elsewhere but not less than 4 sets, 3 nos. for phase fault & 1 no. for earth fault. The Numerical relays in the Incomers shall have at least 5 CT inputs. Relays shall be suitable for CT secondary current of 1A. All transformer feeder relays shall have provision for 3 VT inputs. Relays used in incomers, ties and bus couplers shall have provision of two sets of voltage signal inputs for the purpose of synchronization. ▪ All CT terminals on the relays shall be of fixed type suitable for connection of ring-type lugs to avoid any hazard due to loose connection leading to CT open-circuit. In no circumstances Plug In type connectors shall be used for CT / VT connections. ▪ All numerical relay shall have key pad / keys to allow relay settings from relay front. All hand reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable. Manual resetting shall be possible from remote. ▪ Relays shall have suitable output contact for breaker failure protection. ▪ Relays shall have self-diagnostic feature with self-check for power failure, programmable routines, memory and main CPU failures and a separate output contact for indication of any failure. ▪ Relays shall have at least two sets or groups of two different sets of adaptable settings. Relays shall have multiple IEC / ANSI programmable characteristics. ▪ Design of the relay must be immune to any kind of electromagnetic interference. Vendor shall submit all related type test reports for the offered model along with the offer. 			
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7.0	<p>OTHER PROTECTIONS AND CONTROL FUNCTIONS IN THE RELAYS</p> <ul style="list-style-type: none"> ▪ All cards / hardware of numerical relays shall be suitable for operation in Harsh Environmental conditions with respect to high temperature, humidity & dust. ▪ Relay shall be immune to capacitance effect due to long length of connected control cables. Any external hardware, if required for avoiding mal operation of the relay due to cable capacitance shall be included as a standard feature. ▪ All I/Os shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc. ▪ Numerical relays shall have two level password protections, one for read only and other for authorization for modifying the setting etc. ▪ Numerical relays shall have feature for Time synchronization through the SCADA System / networking. The resolution of time synchronization shall be +/- 1.0 millisecond or better throughout the entire system. ▪ Relays & Ethernet switches shall be suitable to accept both AC & DC supplies with range 120V or 240V with tolerance of 70 % to 120 % of rated voltage & shall be finalized during detailed engineering. ▪ Disturbance Record waveforms, event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data. <p>OTHER PROTECTIONS AND CONTROL FUNCTIONS IN THE RELAYS</p> <ul style="list-style-type: none"> ▪ Trip circuit supervision shall be provided for all feeders to monitor the circuit breaker trip circuit both in pre trip and post trip conditions. ▪ Schematics requiring auxiliary relays / timers for protection function shall be a part of numerical relay. The number of auxiliary relay and timer function for protection function shall be as required. Timer functions shall be programmable for on/off delays. ▪ The numerical relay shall be able to provide supervisory functions such as trip circuit monitoring, circuit breaker state monitoring, PT and CT supervisions and recording facilities with Post fault analysis. ▪ The numerical processor shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with a time stamping using the internal real time clock. Battery backup for real time clock in the event of power supply failure shall be provided. ▪ At least 200 time tagged events / records shall be stored with time stamping. Details of at least 5 previous faults including the type of protection operated, operating time, all currents & voltages and time of fault. 			
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8.0	<ul style="list-style-type: none"> ▪ Diagnostics Automatic testing, power on diagnostics with continuous monitoring to ensure high degree of reliability shall be provided. The results of the self-reset functions shall be stored in battery back memory. Test features such as examination of input quantities, status of digital inputs and relay outputs shall be available on the user interface. ▪ The alarm/status of each individual protection function and trip operation shall be communicated to Switchgear SCADA. ▪ Sequence of events shall have 1 ms resolution at device level. ▪ Measurement accuracy shall be 1 % for rated RMS Current and voltage. 			
	BUSBARS AND INSULATORS <ul style="list-style-type: none"> ▪ All busbar and jumper connections shall be of high conductivity aluminium alloy. They shall be adequately supported on insulators to withstand electrical and mechanical stresses due to specified short circuit currents. ▪ Busbar cross-section shall be uniform throughout the length of switchgear. Busbars and other high voltage connection shall be sufficiently corona free at maximum working voltage. ▪ Contact surfaces at all joints shall be silver plated or properly cleaned and non-oxide grease applied to ensure an efficient and trouble free connection. All bolted joints shall have necessary plain and spring washers. All connection hardware shall have high corrosion resistance. Bimetallic connectors or any other technically proven method shall be used for aluminum to copper connections. ▪ Busbar insulators shall be of arc and track resistant, high strength, non-hygroscopic, non-combustible type and shall be suitable to withstand stresses due to over-voltages, and short circuit current. Busbar shall be supported on the insulators such that the conductor expansion and contraction are allowed without straining the insulators. In case of organic insulator partial discharge shall be limited to 100pico coulomb at rated voltage $\times 1.1 / \sqrt{3}$. Use of insulators and barriers of inflammable material such as Hylam shall not be accepted. ▪ Successful Bidder shall furnish calculation establishing adequacy of busbar sizes for the specified continuous and short time current ratings. ▪ All busbars shall be color coded. ▪ The temperature of the busbar and all other equipment, when carrying the rated current continuously shall be limited as per the stipulations of relevant Indian Standards, duly considering the specified ambient 			
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9.0	<p>temperature (50 deg. C). The temperature rise of the horizontal and vertical busbars when carrying the rated current shall in no case exceed 55 deg. C for silver plated joints and 40 deg. C for all other type of joints. The temperature rise at the switchgear terminals intended for external cable termination shall not exceed 40 deg. C. Further the switchgear parts handled by the operator shall not exceed a rise of 5 deg. C .The temperature rise of the accessible parts / external enclosure expected to be touched in normal operation shall not exceed 20 deg C.</p>			
	<p>EARTHING AND EARTHING DEVICES</p> <ol style="list-style-type: none"> A copper / galvanized steel earthing bus shall be provided at the bottom and shall extend throughout the length of each switch board. It shall be bolted/ welded to the framework of each panel and each breaker earthing contact bar. The earth bus shall have sufficient cross section to carry the momentary short-circuit and short time fault currents to earth as indicated under switchgear parameters without exceeding the allowable temperature rise. Suitable arrangement shall be provided at each end of the earth bus for bolting to Employer's earthing conductors. All joint splices to the earth bus shall be made through at least two bolts and taps by proper lug and bolt connection. All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical continuity of the whole switchgear enclosure frame work and the truck shall be maintained even after painting. The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions i.e. SERVICE and ISOLATED as well as throughout the intermediate travel. The truck shall also get and remain earthed when the control plug is connected irrespective of its position. All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering shall not be acceptable. Looping of earth connections which would result in loss of earth connection to other devices, 			
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	<p>when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths of earth bus is acceptable.</p> <p>g. VT and CT secondary neutral point earthing shall be at one place only on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit may be removed without disturbing the earthing of other circuits.</p> <p>h. Separate earthing trucks shall be provided by the Contractor for maintenance work. These trucks shall be suitable for earthing the switchgear busbars as well as outgoing / incoming cables or busducts. The trucks shall have a voltage transformer and an interlock to prevent earthing of any live connection. The earthing trucks shall in addition have a visual and audible annunciation to warn the operator against earthing of live connections.</p> <p>As an alternative to separate earthing trucks the Bidder may also offer built-in earthing facilities for the busbars and outgoing / incoming connections, in case such facilities are available in their standard proven switchgear design. The inbuilt earthing switches shall have provision for short circuiting and earthing a circuit intended to be earthed. These switches shall be quick make type, independent of the action of the operator and shall be operable from the front of the switchgear panel. These switches shall have facility for padlocking in the earthed condition.</p> <p>i. Interlocks shall be provided to prevent :</p> <ol style="list-style-type: none"> 1) Closing of the earthing switch if the associated circuit breaker truck is in Service position. 2) Insertion of the breaker truck to Service position if earthing switch is in closed position. 3) Closing of the earth switch on a live connection. Three (3) nos. voltage capacitive dividers shall be provided on each phase of the section intended for earthing and three (3) nos. "RED" neon lamps connected to these on the panel front for visual indication. 4) Energizing an earthed Section: <p>Complete details of arrangement offered shall be included in the Techno commercial bid, describing the safety features and interlocks.</p>		
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10.0	<p>j. The earthing device (truck / switch) shall have the short circuit withstand capability equal to that of associated switchgear panel. 4 NO + 4 NC of auxiliary contacts of the earthing device shall be provided for interlocking purpose.</p> <p>k. All hinged doors shall be earthed through flexible earthing braid.</p>			
	<p>PAINTING</p> <p>All sheet steel work shall be pretreated, in tanks, in accordance with IS: 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS: 6005. The phosphated surfaces shall be rinsed and passivated. After passivation, Electrostatic Powder Coating shall be used. Powder should meet requirements of IS 13871 (Powder costing specification). Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the Employer. The paint thickness shall not be less than 50 microns. Finished parts shall be suitably packed and wrapped with protective covering to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.</p>			
11.0	<p>INSTRUMENT TRANSFORMERS</p> <p>a. All current and voltage transformers shall be completely encapsulated cast resin insulated type, suitable for continuous operation at the ambient temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated load and the outside ambient temperature is 50 deg. C. The class of insulation shall be E or better.</p> <p>b. All instrument transformers shall withstand the power frequency and impulse test voltage specified for the switchgear assembly. The current transformer shall further have the dynamic and short time ratings at least equal to those specified for the associated switchgear and shall safely withstand the thermal and mechanical stress produced by maximum fault currents specified when mounted inside the switchgear for circuit breaker modules.</p> <p>c. The parameters of instrument transformers specified in this specification are tentative and shall be finalized by the Employer in due course duly considering the actual burden of various relays and other devices finally selected. In case the Bidder finds that the specified ratings are not adequate for the relays and other devices offered by him, he shall offer</p>			
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	<p>instrument transformer of adequate ratings and shall bring out this fact clearly in his Techno commercial bid.</p> <p>d. All instrument transformers shall have clear indelible polarity markings. All secondary terminals shall be wired to separate terminals on an accessible terminal block.</p> <p>e. Current transformers may be multi or single core and shall be located in the cable termination compartment. All voltage transformers shall be single phase type. The bus VTs shall be housed in a separate panel on a truck so as to be fully withdrawable.</p> <p>f. Core balance CTs (CBCT) of ratio 50/1A shall be provided on outgoing transformer feeders having phase CT ratio more than 50/1A. These CBCTs shall be mounted inside the switchgear panel. The window size of CBCT's shall be based on the overall diameter of the cables, to be finalized during detailed engineering. The CBCT shall be of circular window type.</p> <p>g. All voltage transformers shall have suitable HRC current limiting fuses on both primary and secondary sides. Primary fuses shall be mounted on the withdrawable portion. Replacement of the primary fuses shall be possible with VT truck in ISOLATED position. The secondary fuses shall be mounted on the fixed portion and the fuse replacement shall be possible without drawing out the VT truck from Service position.</p> <p>h. All voltage transformers shall be designed and manufactured for 0.8 Tesla operating point on B-H curve. VT shall be fully insulated type (i.e. double pole construction and neutral side fully insulated to rated BIL). VT shall be manufactured without any joint in secondary winding.</p>			
12.0	<p>SURGE ARRESTOR</p> <p>The surge arrestors shall be of metal oxide, gapless type generally in accordance with IEC 60099-4 and suitable for indoor duty. These shall be mounted within the switchgear cubicle between line and earth, preferably in the cable compartment. Surge arrestor selected shall be suitable for un-earthed system and rating shall be in such a way that the value of steep fronted switching over voltage generated at the switchgear terminals shall be limited to the requirements of switchgear.</p>			
13.0	<p>CONTROL SUPPLY AND SPACE HEATER SUPPLY</p> <ol style="list-style-type: none"> Each switchboard shall be provided at least two (02) Nos of 110/220V DC feeders for the control supply. In case two DC sources are provided, then blocking diodes of peak inverse voltage of 1000 Volts has to be provided in both circuit. Diode 			
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14.0	<p>details like rated current, heat sink sizing and temperature etc. Shall be submitted for review and approval.</p> <ol style="list-style-type: none"> One 240V/63A single phase to neutral AC supply feeder per switchboard / Switchboard section for space heater supply. Bidder shall provide necessary switch and fuse to receive, isolate and distribute to each panel. Each sub circuit shall have separate fuses. Fuse size shall be determined so as to achieve selective clearance between main circuit and sub circuit in case of fault. Potential circuits for protection and metering shall also be protected by separate fuse. All fuses shall be of HRC link type conforming to IS: 13703 / 9385 mounted on suitable fuse bases. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage. All accessible live connection to fuse bases shall be adequately shrouded. All DC circuits shall be fused on both poles. Single phase AC circuits shall have fuses on line and link on neutral. 			
	<p>SPACE HEATER</p> <ol style="list-style-type: none"> Each switchgear panel shall be equipped with thermostatically controlled space heater(s), suitably located in breaker and cable compartments to prevent condensation within the enclosure. The space heater shall be connected to 240V single phase AC auxiliary supply available in the switchgear, through switches and fuses provided separately for each panel. A 240V single phase 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF switch for connection of hand lamp. 			
15.0	<p>TERMINAL BLOCKS</p> <ol style="list-style-type: none"> Terminal blocks shall be 650V grade, 10Amps rated, 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. Terminal blocks for CT and VT secondary leads shall be of stud type, made up of unbreakable polyamide 6.6 grade. They shall be provided 			
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16.0	<p>with links to facilitate testing, isolation star / delta formation and earthing. Terminal blocks for CT secondary shall have the short circuiting facility. The terminals for remote ammeter connection etc. shall also be disconnecting type only. All metal parts shall be of non-ferrous material. Screws shall be captive.</p> <ol style="list-style-type: none"> At least 10% spare terminals for external connections shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminals shall also be available in each panel. There shall be minimum clearances of 250 mm between the terminal blocks and the cable gland plate and 150 mm between two rows of terminal blocks. All panel wiring for external connections shall terminate on separate terminal blocks which shall be suitable for connecting two (2) stranded copper conductors of 2.5 sq. mm on each side, or alternatively, the terminal blocks shall have the possibility of double shorting space to facilitate looping. 			
	<p>SWITCHGEAR WIRING</p> <ol style="list-style-type: none"> All Switchgear panels shall be supplied completely wired internally upto the terminal block ready to receive Employer's external cabling. All inter cubicle wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided / done by the Contractor. All internal wiring shall be carried out with 650 V grade, single core, 1.5 sq. mm. stranded copper wires having minimum of seven strands per conductor and color coded, PVC insulation. CT circuits shall be wired with 2.5 sq. mm. wires which otherwise are similar to the above. Extra flexible wires shall be used for wiring between fixed and moving parts such as hinged doors. All wiring shall be properly supported neatly arranged, readily accessible and securely connected to equipment, terminals and terminal blocks. Wiring troughs or gutters be used for this purpose. Internal wire terminals shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor. Insulation sleeves shall be provided over the exposed parts of lugs. Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS: 375. Red Ferrules should be provided on trip circuit wiring. 			
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17.0	<p>6. Interconnection to adjacent panels shall be brought out to a separate set of terminal blocks located near the slots or holes, meant for the interconnecting wires. Arrangement shall permit neat layout and easy interconnections to adjacent panels at site and wires for this purpose shall be provided by Contractor looped and bunched properly inside the panels.</p> <p>7. Contractor shall be fully responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment.</p> <p>8. The Contractor shall provide the necessary clamps wiring troughs etc. for all wiring in side the switchgear enclosed including the Employer's power and control cables.</p>		
	<p>POWER CABLE TERMINATION</p> <p>1. Cable termination compartment shall receive stranded Aluminium conductor, XLPE insulated, shielded, armored / unarmored, PVC jacketed, single core / three core, unearthed / earthed grade power cable(s).</p> <p>2. A minimum clearance of about 600 mm shall be kept between the cable lug bottom ends and gland plates for stress cone formation for XLPE cables. Interphase clearance in the cable termination compartment shall be adequate to meet electrical and mechanical requirement besides facilitating easy connections and disconnection of cables. Dimensional drawing of cable connection compartment showing the location of lug, glands, CTs, gland plates etc. and the electrical clearances available shall be submitted for Employer's approval during detail engineering.</p> <p>3. Cable termination compartment shall have provision for termination of power cables of sizes as indicated during detailed engineering with removable undrilled gland plates. For all single core cables gland plates shall be of nonmagnetic material. Cable entry shall be from bottom. Any change will be intimated later.</p>		
18.0	<p>NAME PLATES AND LABELS</p> <p>1. Each switch board shall have a name plate for its identification. All enclosure mounted equipment hall be provided with individual engraved name plates for clear equipment identification. All panels shall be identified on front as well as backside by large engraved name plates giving the distinct feeder description along with panel numbers. Back side name plates shall be fixed in panel frame and not</p>		
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19.0	<p>on the rear removable cover.</p> <ol style="list-style-type: none"> 2. Name plate shall be of non-rusting metal or 3-ply lamicaid with white engraved letterings, on black background. Inscriptions and lettering shall be subjected to Employer's approval. 3. Suitable stenciled paint mark shall be provided for identification of all equipment, located inside the enclosure, as well as for door mounted equipment, from the back side in addition to plastic sticker labels, if provided. These labels shall be located directly by the side of the respective equipment, shall be clearly visible and shall not be hidden by equipment wiring. Labels shall have device number as as per the wiring drawings. Type of labels and fixing of labels shall be such that they are not likely to peel off / fall off during prolonged use. <p>MODULE DESCRIPTION</p> <p>Depending on functional requirement each switchgear panel has been categorized under specific modules, defined hereafter. Each module shall be complete with all necessary hardware as required functionally and as per approved control schematic drawings.</p> <ol style="list-style-type: none"> a. Circuit Breaker Module <ul style="list-style-type: none"> All circuit breaker modules shall have the following accessories: <ul style="list-style-type: none"> • Current / Voltage transformers as per requirement • Relays as per relevant clauses / single line diagrams • Spring charging motor, with its protection and control • Auxiliary contacts. • Terminal blocks b. P.T. Module Type – G <table> <thead> <tr> <th>Item Description</th><th>Module G</th></tr> </thead> <tbody> <tr> <td>1 phase VT*</td><td>3</td></tr> <tr> <td>Fuses (VT Primary)</td><td>3</td></tr> <tr> <td>Fuses (VT Secondary)</td><td>6</td></tr> </tbody> </table> <p>* 33 kV System the VT ratio is $33/\sqrt{3}$ KV / $110/\sqrt{3}$ V</p> 	Item Description	Module G	1 phase VT*	3	Fuses (VT Primary)	3	Fuses (VT Secondary)	6
Item Description	Module G								
1 phase VT*	3								
Fuses (VT Primary)	3								
Fuses (VT Secondary)	6								
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20.0

TESTS

i. TYPE TESTS

All equipment to be supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the following type tests carried out not earlier than *ten* years prior to 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.

A)	Reports of the following type tests carried out on circuit breaker / circuit breaker panels, of each voltage class and current rating shall be submitted.
	1) Short circuit duty test on circuit breaker, mounted inside the panel offered along with CTs , bushing and separators
	2) Short time withstand test on circuit breaker, mounted inside panel offered together with CTs, bushings and separators.
	3) Power frequency withstand test on breaker mounted in side panel.
	4) Lightning impulse withstand test on breaker mounted in side panel.
	5) Temperature rise test on breaker and panel together. For this test, the test set up shall include three panels with breakers, the test breaker and panel being placed in the centre.
	The adjacent panels shall also be loaded to their rated current capacity. Alternatively the test panel may be suitably insulated at the sides, which will be adjoining to other panels in actual site configuration
	6) Internal Arc Test as per IEC 62271-200
	7) Measurement of resistance of main circuit.
	8) Mechanical operation test.
B)	Short circuit withstand test of earthing device (truck / switch).

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- However if the contractor is not able to submit report of the type test(s) conducted not earlier than *ten* years prior to 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 free of 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.
- 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.
- 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.
- Type test reports for the following tests on the model of the Numerical relays, Ethernet switches shall be submitted for employer’s review.

SN	TEST ITEMS	Standard
1	Dimensions of structure and visual inspection	IEC 60297-3-101
2	Functional requirements:	Relevant IEC 60255-100 series
	– Steady-state simulation	
	– Dynamic simulation	
3	Product safety requirements (including the dielectric tests and thermal short time rating)	IEC 60255-27
4	EMC requirements:	IEC 60255-26
	– Emission	
	– Immunity	
5	Energizing quantities:	
	– Burden	N/A
	– Change of auxiliary energizing quantity	IEC 60255-11
6	Contact performance	N/A
7	Communication requirements	IEC 61850
8	Climatic environmental requirements:	IEC 60068-2-14, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-78, IEC 60068-2-30,
	– Cold	
	– Dry heat	
	– Change of temperature	
	– Damp heat	

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		IEC 60255-27
9	Mechanical requirements: – Shock	IEC 60255-21-1,
	– Vibration	IEC 60255-21-2,
	– Bump	IEC 60255-21-3
	– Seismic	
10	Enclosure protection	IEC 60529, IEC 60255-27

- (a) Two (2) protected soft copies on CD-ROM of the approved test results shall be furnished with the equipment. These shall include complete reports and results of the routine tests and type tests (if the latter is carried out) on equipment. If the type tests are not conducted, the CDs shall contain copies of the results of type tests carried out on identical equipment earlier.
- (b) Testing to observe compliance to degree of protection, shall be checked for each switch board enclosure and busbar chambers during routine inspection shall be as under.
1. IP -4X: It shall not be possible to insert a one (1) mm. dia steel wire into the enclosure from any direction, without using force.
 2. IP-5X: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.

ii. ROUTINE TESTS

All acceptance and routine tests as per the specification and relevant standards IEC 62271-200 & IEC 62271-100 shall be carried out. Charges for these shall be deemed to be included in the equipment price

An indicative lists of tests / checks is mentioned as QA chapter on HT switchgear. However, the manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

iii. COMMISSIONING CHECKS / TESTS

After installation of panels, power and Control wiring and connections, Contractor shall perform commissioning checks as listed below to verify proper operation of switchgear / panels and correctness of all equipment in all respects. In addition the Contractor shall carry out all other checks and tests recommended by the manufacturers.

General

- (a) Check name plate details according to specification.

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	<p>(b) Check for physical damage</p> <p>(c) Check tightness of all bolts, clamps and connecting terminals</p> <p>(d) Check earth connections.</p> <p>(e) Check cleanliness of insulators and bushings</p> <p>(f) Check heaters are provided</p> <p>(g) H.V. test on complete switchboard with CT & breaker in position.</p> <p>(h) Check all moving parts are properly lubricated.</p> <p>(i) Check for alignment of busbars with the insulators to ensure alignment and fitness of insulators.</p> <p>(j) Check for interchange ability of breakers.</p> <p>(k) Check continuity and IR value of space heater.</p> <p>(l) Check earth continuity for the complete switchgear board.</p> <p>Circuit Breakers</p> <p>(a) Check alignment of trucks for free movement.</p> <p>(b) Check correct operation of shutters.</p> <p>(c) Check slow closing operation (if provided)</p> <p>(d) Check control wiring for correctness of connections, continuity and IR values.</p> <p>(e) Manual operation of breakers completely assembled.</p> <p>(f) Power closing / opening operation, manually and electrically at extreme condition of control supply voltage.</p> <p>(g) Closing and tripping time.</p> <p>(h) Trip free and anti-pumping operation.</p> <p>(i) IR values, resistance and minimum pick up voltage of coils.</p> <p>(j) Simultaneous closing of all the three phases.</p> <p>(k) Check electrical and mechanical interlocks provided.</p> <p>(l) Checks on spring charging motor, correct operation of limit switches and time of charging</p> <p>(m) All functional checks.</p> <p>a. Current Transformers</p> <p>(a) IR Value between windings and winding terminals to body.</p> <p>(b) Polarity tests.</p> <p>(c) Ratio identification checking of all ratios on all cores by primary injection of current.</p>			
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	<p>(d) Magnetisation characteristics & secondary winding resistance.</p> <p>(e) Spare CT cores, if any to be shorted and earthed.</p> <p>b. Voltage Transformers</p> <p>a) Insulation resistance test.</p> <p>b) Ratio test on all cores.</p> <p>c) Polarity test.</p> <p>d) Line connections as per connection diagram.</p> <p>c. Cubicle Wiring</p> <p>(a) Check all switch developments.</p> <p>(b) It should be made sure that the wiring is as per relevant drawings. All interconnections between panels shall similarly be checked.</p> <p>(c) All the wires shall be checked for IR value to earth.</p> <p>(d) Functional checking of all control circuit e.g. closing, tripping interlock, supervision and alarm circuit including proper functioning of component / equipment.</p> <p>(e) Check terminations and connections.</p> <p>(f) Wire ducting.</p>			
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C-3) INVERTER TRANSFORMER AND AUXILIARY TRANSFORMER

TECHNICAL REQUIREMENTS

Sr. No.	TRANSFORMER	INVERTER TRANSFORMER (IT)	AUXILIARY TRANSFORMER (AT)
i)	VA Rating & Quantity	As per system requirement and SLD*	
ii)	Voltage Ratio (KV)	As per system requirement and SLD*	
iii)	Duty, Service & Application	Continuous Solar Inverter application and converter duty (Outdoor)	Continuous application (Outdoor)
iv)	Winding	AS PER SLD	TWO
v)	Frequency	50 Hz	50 Hz
vi)	Nos. of Phase	THREE	THREE
vii)	Vector Group & Neutral earthing	As per system requirement and SLD*	
viii)	Cooling	ONAN	ONAN
ix)	Tap Changer	As per system requirement and SLD*	
x)	Impedance at75 ⁰ C		As per system requirement and SLD*
	a) Principal Tap		
	b) Other Taps		
xi)	Permissible Temperature rise over an ambient of 50 deg C (irrespective of tap)		
	a) Top Oil	50 deg.C	50 deg.C
	b) Winding	55 deg.C	55 deg.C
xii)	SC withstand time (thermal)	2 sec.	2 sec.
xiii)	Fault Level & Bushing CT	As per system requirement and SLD*	
xiv)	Termination	As per system requirement and SLD*	
xv)	Bushing rating, Insulation class (Winding & bushing)	As per relevant IS/IEC (However Inverter Transformer LV side winding & bushing insulation class shall be of atleast 3.6 kV)	
xvi)	Noise level	AS PER NEMA TR-1	
xvii)	Loading Capability	Continuous operation at rated MVA on any tap with voltage variation of +/-10%. also transformer shall be	

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		capable of being loaded in accordance with IS:6600/ IEC60076-7.
xviii)	Flux density	Not to exceed 1.9 Wb/sq.m. at any tap position with +/-10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due to combined voltage and frequency fluctuations: a) 110% for continuous rating. b) 125% for at least one minute. c) 140% for at least five seconds. Bidder shall furnish over fluxing char. up to 150%
xix)	Air Clearance	As per CBIP

* Single Line Diagram (SLD) will be finalized during detailed engineering.

Note:-

- Auxiliary transformers shall be suitable for 3 phase, 4 wire system with additional LVN bushing for equipment earthing.
- Inverter Transformer shall have Shield winding between LV & HV windings. Each LV winding must be capable of handling non-sinusoidal voltage with voltage gradient as per relevant applicable standards. Also shield winding shall be taken out from tank with separate connection with 2 nos. shield bushings and same shall be brought down along with support insulator from tank & copper flat up to the bottom of the tank for independent grounding.
- Auxiliary Transformer up to and including 100 KVA can be either Oil filled or Dry Type (refer relevant clauses for their detail specification).

2.0

CODES AND STANDARDS

Transformers	IS:2026, IS:6600, IEC:60076
Bushings	IS:2099, IEC:60137
Insulating oil	IEC 60296
Bushing CTs	IS:2705, IEC 60185

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2.1.1	Indian Electricity Act 2003, BEE Guideline 3 star or better & CEA notifications			
	<p>General Construction</p> <p>Transformer shall be constructed in accordance to IS:2026 and IS:3639 or equivalent to any other international standard. Transformer shall be complete & functional in all respect and shall be in scope of supplier.</p> <p>The other important construction particulars shall be as below.</p> <ol style="list-style-type: none"> The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the cover shall be of welded construction and there should be provision for lifting by crane. A double float type Buchholz relay conforming to IS: 3637 shall be provided. Suitable Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc. All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer if not opened for maintenance at site The transformer shall be provided with conventional single compartment conservator. The top of the conservator shall be connected to the atmosphere through indicating type cobalt free silica gel breather (in transparent enclosure). Silica gel shall be isolated from atmosphere by an oil seal. Transformer shall have adequate capacity Conservator tank to accommodate oil preservation system and volumetric expansion of total transformer oil. Transformer shall have Oil Temperature Indicator and Winding temperature Indicator with accuracy class of +/-2 deg. The radiators shall be detachable type, mounted on the tank with shut off valve at each point of connection to the tank, lifts, along with drain plug/valve at the bottom and air release plug at the top. M. Box shall be of sheet steel, dust and vermin proof provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. Marshalling Box of all 			
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transformers shall be preferably Tank Mounted. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber. Also Marshalling Box, shall be at least 450 mm above ground level. Wiring scheme (TB details) shall be engraved in a stainless steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.

2.1.2
Windings

- a) The bidder shall ensure that windings of all transformers are made in dust proof & conditioned atmosphere.
- b) The conductors shall be of electrolytic grade copper free from scales & burrs.
- c) All windings of the transformers shall have uniform insulation.
- d) Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratio.

2.1.3
Core

- a) The core shall be constructed from non-ageing, cold rolled, super grain oriented silicon steel laminations equivalent to M4 grade steels or better.
- b) Core isolation level shall be 2 kV (rms.) for 1 minute in air.
- c) Adequate lifting lugs will be provided to enable the core & windings to be lifted.

2.1.4
Insulating oil

No inhibitors shall be used in the transformer oil. The oil supplied with transformers shall be new and previously unused and must conform to following while tested at supplier's premises and shall have following parameters.

S.No	Property	Permissible values
1.	Kinematic Viscosity, mm ² /s	≤ 12 at 40 ° C ≤ 1800.0 at (-)30 ° C
2.	Flash Point, ° C	≥ 140° C
3.	Pour point, ° C	≤ (-)40 ° C
4.	Appearance	Clear , free from sediment and suspended matter
5.	Density kg/dm ³ at 20 ° C	≤ 0.895
6.	Interfacial Tension N/m at 25°	≥ 0.04

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S.No	Property	Permissible values
	C	
7.	Neutralisation value, mgKOH/g	≤ 0.01
8.	Corrosive sulphur	Non Corrosive
9.	Water content mg/kg	≤ 30 in bulk supply ≤ 40 in drum supply
10.	Anti-oxidants additives	Not detectable
11.	Oxidation Stability -Neutralization value, mgKOH/g -Sludge, % by mass	≤ 1.2 ≤ 0.8
12.	Breakdown voltage As delivered, kV After treatment, kV	≥ 30 ≥ 70
13.	Dissipation factor, at 90° C And 40 Hz to 60 Hz	≤ 0.005
14.	PCA content	$\leq 1\%$
15.	Impulse withstand Level, kVp	≥ 145
16.	Gassing tendency at 50 Hz after 120 min, mm ³ /min	≤ 5

Subsequently oil samples shall be drawn at:

2.1.5

Bushings

- a) Bushing below 52 kV shall be oil communicating type with porcelain insulator.
- a) No arcing horns to be provided on the bushings.
- b) Inverter Transformer LV bushing palms shall be silver/tin plated.

2.1.6

Bushing CTs

Shall be of adequate rating for protection as required, WTI etc. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted.

All CT terminals shall be provided as fixed type terminals on the M. Box to avoid any hazard due to loose connection leading to CT opening. In no circumstances Plug In type connectors shall be used for CT.

2.1.7

Valves

All valves upto and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings.

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2.1.8

Gaskets

- Sampling & drain valves should have zero leakage rate.
- Gasket shall be fitted with weather proof, hot oil resistant, rubberized cork gasket.
 - If gasket is compressible, metallic stops shall be provided to prevent over compression.
 - The gaskets shall not deteriorate during the life of transformer if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer. The quality of these joints is considered established, only if the joints do not exhibit any oil leakage or sweating for a continuous period of at least 3 months during the guarantee period. In case any sweating / leakage is observed, contractor shall rectify the same & establish for a further period of 3 months of the same. If it is not established during the guaranteed period, the guaranteed period shall be extended until the performance is established.

2.1.9

PAINTING

PARTS NAME	TYPE OF PAINT	NO.OF COATS	TOTAL DFT
Inside of tank and accessories (except M Box)	Oil & heat resistant fully glossy white	One coat	Atleast 30 micron
External surface of transformer and accessories including M Box (except radiators)	Chemical resistant epoxy zinc phosphate primer, MIO (Micaceous iron oxide) as intermediate paint followed by polyurethane finish paint (RAL 5012 Blue)	One coat each	Atleast 100 micron
External Radiator surface	Anticorrosive primary paint followed by high quality full glossy outer finish paint (RAL 5012 Blue)	Two coats each	Atleast 100 micron
Internal Radiator surface	Hot oil proof, low viscosity varnish and subsequent flushing with transformer oil	---	---
Internal surface of M Box	Chemical resistant epoxy zinc phosphate primer	Two coats	Not less than 100

CLAUSE NO.

TECHNICAL SPECIFICATIONS

PARTS NAME	TYPE OF PAINT	NO.OF COATS	TOTAL DFT
	followed by chemical and heat resistant epoxy enamel white paint	each	micron

2.1.10

Neutral Earthing Arrangement

Neutral earthing shall be done as per system requirement and SLD. In case of solidly earthed neutral of Transformers, it shall be brought through insulated support from tank to the ground level at a convenient point with 2 nos. copper flat, for connection to ground network (as applicable).

2.1.11

FITTINGS

Following fittings shall be provided with Transformers covered under this sub section.

a)	-Conservator for main tank (transformer above 100 KVA shall be provided with with MOG with low oil level alarm contact), drain valve & indicating type free Cobalt free breather with transparent enclosure (maximum height 1400 mm above ground level) etc.
b)	-Buchholz relay, double float type with alarm and trip contacts, along with suitable gas collecting arrangement.
c)	- For Inverter transformer and transformers with rating 2 MVA & above, shall be provided with minimum two numbers of spring operated PRD (with trip contacts) with suitable discharge arrangement for oil shall be provided. - For Auxiliary transformers below 2 MVA, diaphragm type explosion vent shall be provided.
d)	OTI & WTI shall be 150 mm dial type with alarm and trip contacts with max. reading pointer & resetting device (maximum height 1500 mm above ground level). For Inverter Transformers, WTI shall be provided for all windings.
e)	Top & bottom filter valves with threaded male adapters, bottom sampling valve, drain valve/sludge removal valve at the bottom most point of the tank.
f)	Air release plug, bushing with metal parts & gaskets, terminal connectors on bushings (as applicable).
g)	Prismatic/toughened glass oil gauge for transformers.
h)	Bi-directional wheel/skids, M.Box, OCTC, Bushing CTs (as applicable), Insulating Oil, Cooling equipment.

2.1.12
Tests and Inspection

In case the bidder/contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit the type test reports to the owner for waiver 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.

In case the Bidder is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests under this contract at no additional cost to the Employer and submit the reports for approval.

SN	ROUTINE TESTS	
1.	All routine test shall be carried out in accordance with IEC 60076.	√
2.	Measurement of Voltage Ratio & phase displacement (as per IEC 60076-1)	√
3.	Measurement of winding resistance on all the taps (as per IEC 60076-1)	√
4.	Vector group and Polarity Check (as per IEC 60076-1)	√
5.	Magnetic Balance and Magnetising Current Test	√
6.	Measurement of no load current with 415 V, 50 Hz AC supply	√
7.	Measurement of no load losses and current at 90%, 100% & 110% of rated voltage (as per IEC 60076-1)	√
8.	Load Loss & Short Circuit Impedance Measurement on principal & Extreme Taps	√
9.	IR measurement (As per IEC 60076-1)	√

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SN	ROUTINE TESTS	
10.	Measurement of capacitance & tan delta to determine capacitance between winding & earth.	√
11.	Separate Source Voltage Withstand Test (as per IEC 60076-3)	√
12.	Induced overvoltage test	√
13.	Repeat no load current/loss & IR after completion of all electrical test	√
14.	Oil leakage test on completely assembled transformer along with radiators (as per relevant clause of this sub section)	√
15.	Jacking test followed by D.P. test	√
16.	Marshalling Box/Cable box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.	√
17.	IR measurement on wiring of Marshalling Box.	√

SN	TYPE TESTS# (Shall be carried out on one transformer of each rating)	
1.	Lightning impulse(Full & Chopped Wave) test on windings (as per IEC 60076-3)	√
2.	Short circuit test (special test) as per IEC 60076-5.	√
3.	Temperature Rise test at a tap corresponding to maximum losses as per IEC 60076. Gas Chromatography shall be conducted on oil sample taken before & immediately after temp. rise test. Gas analysis shall be as per IS: 9434 (based on IEC: 60567), results will be interpreted as per IS: 10593 (based on IEC: 60599).	√
4.	Measurement of harmonics of no load current (special test)	√
5.	Measurement of acoustic noise level as per NEMA TR-1 (special test)	√
6.	Tank Vacuum & Pressure Test (as per CBI norms)	√

NOTE:-

- i) (#) All the type and special tests shall be conducted after performing Short Circuit Test. If Tank Vacuum & Pressure Test is to be carried out then it shall be conducted before SC test.

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<p>2.1.12.1</p>	<p>ii) Inverter Transformer LV winding Di-electric tests shall be carried out corresponding to levels (as per IEC 60076) for 3.6 kV class.</p> <p>iii) Type and Special tests are not applicable in case of auxiliary transformers of rating including 100 KVA and below.</p> <p>Oil Leakage test on assembled Transformer (ROUTINE TEST) All tank & oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature & applying pressure equal to the normal pressure plus 35 KN/sq. m measured at the base of the tank. The pressure shall be maintained for a period of not less than 6 hours during which time no sweating shall occur.</p> <p>3.00.00 Fire Fighting arrangements for Transformers shall be provided if applicable as per statutory requirements.</p> <p>4.00.00 Firewall as applicable (as per IS 3034) shall be provided of minimum 230 mm thickness of RCC wall subject to NTPC approval.</p> <p>5.00.00 DRY TYPE AUXILIARY TRANSFORMERS:</p> <p>Dry Type Transformer shall be constructed in accordance to IS:2026, IS:11171, Indian Electricity Act 2003, BEE Guideline & CEA notifications or equivalent to any other international standard. Transformer rating and all related technical parameters including tap changer (if applicable) shall be as per system requirement/SLD and relevant standards. Transformer shall be suitable for continuous indoor duty application. Transformer shall be complete & functional in all respect. The other important construction particulars shall be as below.</p> <p>a) The transformers shall be housed in a metal protective housing, having a degree of protection of IP-23. The enclosure shall be provided with suitable hardware (as required).</p> <p>b) The conductors shall be of electrolytic grade copper free from scales & burrs.</p> <p>c) Dry Type Transformer windings shall be of class F insulation or better.</p> <p>d) The core shall be constructed from non-ageing, cold rolled, grain oriented silicon steel laminations.</p> <p>e) The fittings/accessories including protection/monitoring device generally required for satisfactory operation of the transformer, are to be provided.</p>
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6.00.00	Transformer efficiency shall be as per Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electrical Lines) regulation, 2010.			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
1.0	C-4) HT CABLES			
	<p>CODES & STANDARDS</p> <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 the cables shall conform to the requirements of the following standards and codes:</p> <p>IS:7098 Cross linked polyethylene insulated PVC sheathed cable for (Part -II) working voltage from 3.3KV upto & including 33 KV</p> <p>IS : 3961 Recommended current ratings for cables</p> <p>IS : 3975 Low Carbon Galvanized steel wires, formed wires and tapes for armouring of cables.</p> <p>IS : 4905 Methods for random sampling.</p> <p>IS : 5831 PVC insulation and sheath of electrical cables.</p> <p>IS : 8130 Conductors for insulated electrical cables and flexible cords.</p> <p>IS : 10418 Specification for drums for electric cables.</p> <p>IS : 10810 Methods of tests for cables.</p> <p>ASTM-D -2843 Standard test method for density of smoke from the burning or decomposition of plastics.</p> <p>ASTM-D-2863 Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.</p> <p>IEC-754 (Part-I) Test on gases evolved during combustion of electric cables.</p> <p>IEEE-383 Standard for type test of Class IE Electric Cables.</p> <p>IEC -332 Tests on Electric cables under fire conditions.</p> <p>Part-3 : Tests on bunched wires or cables (category -B)</p>			
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2.0
TECHNICAL REQUIREMENTS

The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground (buried) installation with chances of flooding by water.

Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.

Copper/aluminium conductor used in power cables shall have tensile strength as per relevant standards. Conductors shall be multi stranded.

XLPE insulation shall be suitable for continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg C.

The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS : 5831.

For single core armoured cables, armouring shall be of aluminum wires. For multi core armoured cables armouring shall be of galvanized steel as follows: -

SI	Calculated nominal dia of cable under armour	Size and Type of armour
i)	Upto 13 mm	1.4mm dia GS wire
ii)	Above 13 upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
iii)	Above 25 upto 40 mm	0.8mm thick GS formed wire / 2.0 mm dia GS wire
iv)	Above 40 upto 55mm	1.4 mm thick GS formed wire/ 2.5 mm dia GS wire
v)	Above 55 upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
vi)	Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

The aluminium used for armouring shall be of H4 grade as per IS:8130 with maximum resistivity of 0.028264 ohm-sq. mm/ mtr. at 20 deg.C. The types and sizes of aluminium armouring shall be same as indicated for galvanised steel.

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	<p>The gap between armour wires / formed wire shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of GS wires/formed wires.</p> <p>Outer sheath shall be of PVC black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.</p> <ul style="list-style-type: none"> (a) Oxygen index of min. 29 (to ASTM D 2863) (b) Acid gas emission of max. 20% (to IEC-754-I). (c) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTM D-2843. <p>Cores of the cables of upto 3 cores shall be identified by colouring of insulation or by providing coloured tapes helically over the cores with Red, Yellow & Blue colours.</p> <p>In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath:</p> <ul style="list-style-type: none"> (a) Cable size and voltage grade - To be embossed (b) Word 'FRLS' at every 5 metre - To be embossed (c) Screen Fault current _ _ _KA for _ _ _ Sec. (Value of current & time shall be indicated) (d) Sequential marking of length of the cable in metres at every one metre. -To be embossed / printed <p>The embossing / printing shall be progressive, automatic, in line and marking shall be legible and indelible.</p> <p>All cables shall meet the fire resistance requirement as per IEEE - 383 with cable installations made in accordance with 'Flammability Test' and as per Category-B of IEC 332 Part -3.</p> <p>Allowable tolerances on the overall diameter of the cables shall be ± 2 mm maximum over the declared value in the technical data sheets.</p> <p>In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.</p>
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The cross-sectional area of the metallic screen strip/tape shall be considered in design calculations.

The eccentricity shall be calculated as

$$\frac{t_{\max} - t_{\min}}{t_{\max}} \times 100$$

and the ovality shall be calculated as

$$\frac{d_{\max} - d_{\min}}{d_{\max}} \times 100$$

Where t-max/t-min is the maximum/minimum thickness of insulation and d-max/d-min is the maximum / minimum diameter of the core.

The eccentricity of the core shall not exceed 10% and ovality not to exceed 2%

Cable selection & sizing

HT cables shall be sized based on the following considerations:

- Rated current of the equipment
- The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage
- Short circuit withstand capability

De rating Factors

De rating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:

- Variation in ambient temperature for cables laid in air
- Grouping of cables
- Variation in ground temperature and soil resistivity for buried cables.

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<p>3.0</p> <p>CONSTRUCTIONAL FEATURES OF 11 KV AND ABOVE GRADE CABLES</p> <p>Cables shall conform to IS: 7098 Part - II. These cables shall have multi-stranded, compacted circular, aluminium conductors, XLPE insulated, metallic screened suitable for carrying the system earth fault current, PVC outer sheathed. The conductor screen and insulation screen shall both be of extruded semiconducting compound and shall be applied along with the XLPE insulation in a single operation of triple extrusion process so as to obtain continuously smooth interfaces. Method of curing for cables shall be “dry curing / gas curing”.</p> <p>The metallic screen of each core shall consist of copper tape with minimum overlap of 20%. However for single core armoured cables, the armouring shall constitute the metallic part of the screening.</p> <p>4.0</p> <p>CABLE DRUMS</p> <p>Cables shall be supplied in returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.</p> <p>Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stencilled on both sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.</p> <p>5.0</p> <p>TYPE, ROUTINE AND ACCEPTANCE TESTS</p> <p>All equipments to be supplied shall be of type tested design. During detailed 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</p>				
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conducted at an independent laboratory or should have been witnessed by a client.

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.

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

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.

All types and sizes of cables being supplied shall be subjected to type tests, routine tests and acceptance tests as specified below and according to relevant standards.

a) The reports for following type tests shall be furnished for 11kV and above grade HT cables:

Sl	Type Test	Remarks
	Conductor	
1.	Resistance test	
	For Armour Wires / Formed Wires	
2.	Measurement of Dimensions	
3.	Tensile Test	
4.	Elongation test	
5.	Torsion test	For round wires only
6.	Wrapping test	
7.	Resistance test	
8(a)	Mass & uniformity of Zinc Coating tests	For GS wires/formed wires only.
8(b)	Adhesion test	For GS wires/formed wires only
	For XLPE insulation & PVC Sheath	
9.	Test for thickness	

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10.	Tensile strength and elongation test before ageing and after ageing	
11.	Ageing in air oven	
12.	Loss of mass test	For PVC outer sheath only.
13.	Hot deformation test	For PVC outer sheath only.
14.	Heat shock test	For PVC outer sheath only
15.	Shrinkage test	
16.	Thermal stability test	For PVC outer sheath only
17.	Hot set test	For XLPE insulation only
18.	Water absorption test	For XLPE insulation only
19.	Oxygen index test	For PVC outer sheath only
20.	Smoke density test	For PVC outer sheath only
21.	Acid gas generation test	For PVC outer sheath only
22.	Flammability test as per IEC-332 Part-3 (Category -B)	For completed cable only

b) The reports for following type tests shall be furnished for each type(voltage grade) & size of the cable:

Sl	Type Test For all cables
1.	Insulation resistance test (Volume Resistivity method)
2.	High voltage test
For cables of 11KV and above Grade only.	
3.	Partial discharge test
4.	Bending test
5.	Dielectric power factor test
	a) As a function of voltage
	b) As a function of temperature
6.	Heating cycle test
7.	Impulse withstand test

Indicative list of tests/ checks, Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of H.T. Cables enclosed.

C-5) LT CABLES

1.0
LT POWER & CONTROL CABLES

LT Power & control cables shall be of minimum 1100 volts grade XLPE / PVC insulated conforming to IS 1554 for utilization voltages less than equal to 415 V.

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 the cables shall conform to the requirements of the following standards and codes:

IS :1554 - I	PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.
IS : 3961	Recommended current ratings for cables
IS : 3975	Low carbon galvanised steel wires, formed wires and tapes for armouring of cables.
IS : 5831	PVC insulation and sheath of electrical cables.
IS:7098 (Part -I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100V.
IS : 8130	Conductors for insulated electrical cables and flexible cords.
IS : 10418	Specification for drums for electric cables.
IS : 10810	Methods of tests for cables.
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
IEC-754 (Part-I)	Tests on gases evolved during combustion of electric cables.
IEC-332	Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).

2.0
LT POWER CABLES

The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground (buried) installation with chances of flooding by water.

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All cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.

If cables are to be laid underground, laying shall be as per latest relevant IS code.

Copper/aluminium conductor used in power cables shall have tensile strength as per relevant standards. Conductors shall be stranded.

XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg C.


PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.

The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS : 5831.

For single core armoured cables, armouring shall be of copper/aluminium wires/ formed wires. For multicore armoured cables, armouring shall be of galvanised steel as follows :

Calculated nominal dia. of cable under armour	Size and Type of armour
Upto 13 mm	1.4mm dia GS wire
Above 13 & upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
Above 25 & upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
Above 40 & upto 55mm	1.4 mm thick GS formed wire / 2.5mm dia GS wire
Above 55 & upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

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	<p>The aluminium used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264 ohm mm² per meter at 20 deg C. The sizes of aluminium armouring shall be same as indicated above for galvanized steel.</p> <p>The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of GS wire / formed wire.</p> <p>Outer sheath shall be of PVC as per IS: 5831 & black in colour for power cables. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.</p> <p>(a.) Oxygen index of min. 29 (as per IS 10810 Part-58).</p> <p>(b.) Acid gas emission of max. 20% (as per IEC-754-I).</p> <p>(c.) Smoke density rating shall not be more than 60 % (as per ASTM-D-2843).</p> <p>Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:</p> <p>1 core - Red, Black, Yellow or Blue</p> <p>2 core - Red & Black</p> <p>3 core - Red, Yellow & Blue</p> <p>4 core - Red, Yellow, Blue and Black</p> <p>For reduced neutral conductors (in case of power cable), the core shall be black.</p> <p>In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.</p> <p>(a.) Cable size and voltage grade - To be embossed</p> <p>(b.) Word 'FRLS' at every 5 metre - To be embossed</p> <p>(c.) Sequential marking of length of the cable in metres at every one metre -To be embossed / printed</p> <p>The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.</p>
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3.0	<p>All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part-3.</p> <p>Allowable tolerances on the overall diameter of the cables shall be ± 2 mm maximum, over the declared value in the technical data sheets.</p> <p>Repaired cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.</p> <p>CABLE SELECTION & SIZING</p> <p>Cables shall be sized based on the following considerations:</p> <ul style="list-style-type: none">(a) Rated current of the equipment(b) The Maximum voltage drop in the cables (Inverter to Inverter Transformer) shall be limited to 0.5 % of the rated voltage. For other LT cables, Maximum Voltage drop shall be limited to 3% of rated voltage.(c) Short circuit withstand capability <p>This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let out energy of the fuse. For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time.</p>			
	4.0	<p>DERATING FACTORS</p> <p>De rating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:</p> <ul style="list-style-type: none">a) Variation in ambient temperature for cables laid in airb) Grouping of cablesc) Variation in ground temperature and soil resistivity for buried cables. <p>Cable lengths shall be considered in such a way that straight through cable joints is avoided.</p> <p>Cables shall be armoured type if laid in switchyard area or directly buried.</p>		
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5.0	<p>All LT power cables of sizes more than 120 sq.mm. shall be XLPE insulated.</p> <p>CONSTRUCTIONAL FEATURES FOR LT POWER CABLES</p> <p>1.1 KV grade XLPE power cables shall have compacted aluminium/ copper conductor, XLPE insulated, PVC inner-sheathed (as applicable), armoured/ unarmoured, PVC outer-sheathed conforming to IS:7098. (Part-I). Cables which are directly buried shall be armoured.</p> <p>1.1KV grade PVC power cables shall have aluminium/copper conductor (compacted type for sizes above 10 sq.mm), PVC Insulated, PVC inner sheathed (as applicable) armoured/ unarmoured, PVC outer-sheathed conforming to IS:1554 (Part-I).</p>		
6.0	<p>TESTS</p> <p>Indicative list of tests/checks, Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of LT power and control cables enclosed at relevant section.</p> <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> <p>All cables to be supplied shall be of type tested design.</p> <p>During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests 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> <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</p>		
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Change". Minor changes if any shall be highlighted on the endorsement sheet.

The reports for following type tests shall be furnished:

Sl	Type Test	Remarks
	Conductor	
1.	Resistance test	
2.	Tensile Test	For circular non-compacted conductors only
3.	Wrapping Test	For circular non-compacted conductors only
	For Armour Wires / Formed Wires	
4.	Measurement of Dimensions	
5.	Tensile Test	
6.	Elongation test	
7.	Torsion test	For round wires only
8.	Wrapping test	For aluminium wires /formed wires only
9.	Resistance test	
10(a)	Mass & uniformity of Zinc Coating tests	For GS formed wires/ wires only.
10(b)	Adhesion test	For GS formed wires/ wires only.
11.	Adhesion Test	For GS formed wires/ wires only.
	For PVC/ XLPE insulation & PVC Sheath	
12.	Test for thickness	
13.	Tensile strength and elongation test before ageing and after ageing	
14.	Ageing in air oven	
15.	Loss of mass test	For PVC insulation and sheath only.
16.	Hot deformation test	For PVC insulation and sheath only.
17.	Heat shock test	For PVC insulation and sheath only.
18.	Shrinkage test	
19.	Thermal stability test	For PVC insulation and sheath only.
20.	Hot set test	For XLPE insulation only

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Sl	Type Test	Remarks
21.	Water absorption test	For XLPE insulation only
22.	Oxygen index test	For outer sheath only
23.	Smoke density test	For outer sheath only
24.	Acid gas generation test	For outer sheath only
	For Completed cables	
25.	Insulation resistance test (Volume Resistivity method)	
26.	High voltage test	
27.	Flammability test as per IEC-332 Part-3 (Category -B)	

7.0

LT CONTROL CABLES

The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground (buried) installation with chances of flooding by water.

All cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.

Conductor of control cables shall be made of stranded, plain annealed copper.

Outer sheath shall be of PVC as per IS: 5831 & grey in colour for control cables. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.

- (a.) Oxygen index of min. 29 (as per IS 10810 Part-58).
- (b.) Acid gas emission of max. 20% (as per IEC-754-I).
- (c.) Smoke density rating shall not be more than 60 % (as per ASTM D-2843).

Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:

- 1 core - Red, Black, Yellow or Blue
- 2 core - Red & Black
- 3 core - Red, Yellow & Blue
- 4 core - Red, Yellow, Blue and Black

For control cables having more than 5 cores, core identification shall be done by numbering the insulation of cores sequentially, starting by number 1 in the inner layer (e.g. say for 10 core cable, core numbering shall be from 1 to 10). The number shall be printed in Hindu-Arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of insulation. The colour of insulation for all the cores shall be grey only. The numerals shall be legible and indelible. The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing between consecutive numbers shall not exceed 50 mm.

In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.

- (a.) Cable size and voltage grade - To be embossed
- (b.) Word 'FRLS' at every 5 metre - To be embossed
- (c.) Sequential marking of length of the cable in metres at every one metre -To be embossed / printed

The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.

All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part-3.

Repaired cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

8.0

CABLE SELECTION & SIZING

Control cables shall be sized based on the following considerations:

- (a) The minimum conductor cross-section shall be 1.5 sq.mm.
- (b) The minimum number of spare cores in control cables shall be as follows:

No. of cores in cable	Min. No. of spare cores
2C, 3C	NIL
5C	1
7C-12C	2
14C & above	3


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<p>9.0</p> <p>10.0</p>	<p>CONSTRUCTIONAL FEATURES FOR LT CONTROL CABLES</p> <p>1.1 KV Grade Control Cables shall have stranded copper conductor and shall be multicore PVC insulated, PVC inner sheathed, armoured / unarmoured, FRLS PVC outer sheathed conforming to IS: 1554. (Part-I).</p> <p>CABLE DRUMS</p> <p>(a) Cables shall be supplied in returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. However, For Single core cables upto 6 Sq. mm size, supplier can do alternative packaging of whole Drum/Spool to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.</p> <p>(b) Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stenciled on both sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.</p>			
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1.0	C-6) CABLE INSTALLATION METHODOLOGY			
	CODES AND STANDARDS			
	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.			
	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.		
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	<p>IS:6745 Methods for determination of mass of zinc coating on zinc coated iron & steel articles.</p> <p>IS:8308 Compression type tubular in- line connectors for aluminium conductors of insulated cables</p> <p>IS:8309 Compression type tubular terminal ends for aluminium conductors of insulated cables.</p> <p>IS:9537 Conduits for electrical installation.</p> <p>IS:9595 Metal - arc welding of carbon and carbon manganese steels - recommendations.</p> <p>IS:13573 Joints and terminations for polymeric cables for working voltages from 6.6kv upto and including 33kV performance requirements and type tests.</p> <p>BS:476 Fire tests on building materials and structures</p> <p>IEEE:80 IEEE guide for safety in AC substation grounding</p> <p>IEEE:142 Grounding of Industrial & commercial power systems</p> <p>DIN 46267 (Part-II) Non tension proof compression joints for Aluminium conductors.</p> <p>DIN 46329 Cable lugs for compression connections, ring type ,for Aluminium conductors</p> <p>VDE 0278 Tests on cable terminations and straight through joints</p> <p>BS:6121 Specification for mechanical Cable glands for elastomers and plastic insulated cables.</p> <p>Indian Electricity Act.</p> <p>Indian Electricity Rules.</p> <p>Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure</p>			
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2.0	<p>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 along with 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.</p>			
	<p>DESIGN AND CONSTRUCTIONAL FEATURE</p> <p>Inter Plant Cabling</p> <p>Interplant cabling for main routes shall be laid in Cable trenches/cable trays/buried/duct banks. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering. All buried cables shall be armoured</p> <p>Trenches</p> <p>PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.</p> <p>General</p> <p>The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.</p> <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> <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 requirements • Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc 			
3.0	<p>EQUIPMENT DESCRIPTION</p> <p>Cable trays, Fittings & Accessories</p>			
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	<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> <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 relevant IS.</p> <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> <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 galvanised as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm</p> <p>Support System for Cable Trays</p> <p>Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".</p> <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>			
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	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 galvansied surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied		
	d.	All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drill ing and other machining operation.		
	e.	Support system shall be able to withstand		
		<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.		
		PIPES, FITTINGS & ACCESSORIES		
		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		
		GI Pipes shall be of medium duty as per IS:1239		
		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.		
		Hume pipes shall be NP3 type as per IS 458		
		Junction Boxes		
	Junction Boxes with IP:55 degree of protection, shall comprise of a case with hinged door constructed from cold rolled sheet steel of thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall,			
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	<p>columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.</p> <p>Terminal blocks shall be 1100V grade, 10Amps rated, 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 two (2) nos. stranded copper conductors of size upto 2.5 sq mm each. All internal wiring shall be of minimum 1.5 sq. mm cu. Conductor PVC wire.</p> <p>Terminations & Straight Through Joints</p> <p>Termination and jointing kits for 132kV, 33kV, 11kV, 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, taped type or heat shrinkable type. 132kV, 33kV, 11kV and 6.6 kV grade joints and terminations shall be type tested as per IS:13573. 3.3kV grade joints and terminations shall be type tested as per VDE0278. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solderless crimping type cable lugs & ferrule as per DIN standard.</p> <p>Straight through joint and termination shall be capable of withstanding the fault level for the system.</p> <p>1.1 KV grade Straight Through Joint shall be of proven design.</p> <p>Cable glands</p> <p>Cable shall be terminated using double compression type cable glands. Cable glands shall conform to BS:6121 and 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.</p>			
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Cable lugs/ferrules

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 sleeve and shall suit the type of terminals provided on the equipments. Cable lugs and ferrule shall conform to relevant standard

Trefoil clamps

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.

Cable Clamps & Straps


The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment

Receptacles

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 polymide 6.6 grade with adequate

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4.0	<p>current rating and size. The welding receptacles shall be provided with inbuilt ELCB rated for suitable mA sensitivity.</p> <p>Galvanising</p> <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> <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> <p>Welding</p> <p>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</p>			
	<p>INSTALLATION</p> <p>Cable tray and Support System Installation</p> <p>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.</p> <p>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 relevant standard .</p> <p>The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.</p>			
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	<p>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.</p> <p>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.</p> <p>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.</p> <p>Conduits/Pipes/Ducts Installation</p> <p>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.</p> <p>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.</p> <p>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</p> <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>			
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	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		
	For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.			
	Junction Boxes Installation			
	Junction boxes shall be mounted at a height of 1200mm above floor level 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.			
	Cable Installation			
	Cable installation shall be carried out as per IS:1255 and other applicable standards.			
For Cable unloading, pulling etc following guidelines shall be followed in general :				
<ul style="list-style-type: none">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.				
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	<ul style="list-style-type: none"> 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. <p>Cables shall be laid on cable trays strictly in line with cable schedule</p> <p>Power and control cables shall be laid on separate tiers in line with 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 topmost 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 meter. All multi core cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with self-locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multi core power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multi core power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.</p> <p>Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.</p> <p>Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.</p> <p>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.</p> <p>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</p>			
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enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

Wherever few cables are branching out from main trunk route troughs shall be used.

Wind loading shall be considered for designing support as well Cable trays wherever required.

Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.

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.

Separation

At least 300mm clearance shall be provided between :

- HT power & LT power cables,
- LT power & LT control/instrumentation cables,

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
2C,3C	NIL
5C	1
7C-10C	2
14C and above	3

Directly Buried Cables

- Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved

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	<p>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. Reference Drawing for buried cables is included as a tender drawing and enclosed with this specification.</p> <ul style="list-style-type: none"> ▪ 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. <p>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</p> <p>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.</p> <p>The cable laying shall be done in line with the Drawing No. 5714-004-POE-A-007</p> <p>Cable Terminations & Connections</p> <p>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 shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.</p>			
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	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>All cable terminations shall be appropriately tightened to ensure secure and reliable connections.</p>			
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<p>1.0</p> <p>1.1</p> <p>1.2</p> <p>1.3</p> <p>1.4</p> <p>1.5</p>	<p style="text-align: center;">C-7) SCADA</p> <p>GENERAL</p> <p>Contractor shall provide complete SCADA system with all accessories, auxiliaries and associated equipments and cables for the safe, efficient and reliable operation of entire solar plant and its auxiliary systems.</p> <p>Bidder shall include in his proposal all the Hardware, Software, Panels, Power Supply, HMI, Laser Printer, Gateway, Networking equipment and associated Cable etc. needed for the completeness even if the same are not specifically appearing in this specifications.</p> <p>SCADA System shall have the provision to perform the following functions:</p> <ul style="list-style-type: none"> i. Real-time acquisition and display of data, status, alarms and trends ii. Display of status of major equipments in Single Line Diagram(SLD) format iii. Control of switchgears and Inverters iv. Display and storage of measured values v. Display and storage of derived/calculated/integrated values vi. Display and Storage of Alarm, Event and Trends vii. Generate, store and retrieve user configurable Sequence of Event (SOE) Reports viii. Generate, store and retrieve user configurable periodic Reports ix. Remote monitoring of essential parameters on the web using standard modem (Internet connection for transferring data to web shall be taken by Contractor in the name of NTPC Site for O & M period). x. Control and monitoring of status of all the MV/HV/EHV Breakers and Inverters. xi. System self-supervision <p>It shall be possible to remove/replace online various modules (like any I/O module, interface module, etc.) from its slot for maintenance purpose without switching off power supply to the corresponding rack. System design shall ensure that while doing so, undefined signaling and releases do not occur and controller operation in any way is not affected (including controller trip to manual, etc) except that information related to removed module is not available to controller. Further, it shall also be possible to</p>			
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<p>1.6</p> <p>1.7</p> <p>2.0</p> <p>2.1</p>	<p>remove/replace any of the redundant controller module without switching off the power to the corresponding rack and this will not result in system disturbance or loss of any controller functions for the other controller. The on-line removal/insertion of controller, I/O modules shall in no way affect the safety of plant and personnel.</p> <p>The control system shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is affected. Control system shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuit/short circuit. On any of these failures the controlled equipment/parameter shall either remain in last position before failure or shall come to fully open/close or on/off state as required for the safety of plant/personnel/equipment and as finalized during detailed engineering. System shall be designed such that there will be no upset when Power is restored.</p> <p>The Control system shall be designed to operate in non-air conditioned area. However contractor shall provide a Package/Split AC of suitable capacity decided by heat load requirement in SCADA room at Main control room (CMCS).</p> <p>PROGRAMMABLE LOGIC BASED CONTROL SYSTEM AT CMCS ROOM:</p> <p>Bidder has to provide PLC based SCADA at CMCS room as per specification given hereunder. Other requirement related to PLC mentioned elsewhere in this chapter is applicable for PLC to be provided in CMCS. For other locations such as Inverter room, Sub pooling switchgear room (, bidder may offer IO modules/RTU/PLC for completeness of SCADA.</p> <p>PLC PROCESSOR</p> <p>The processor unit shall be capable of executing the following functions:-</p> <ul style="list-style-type: none"> a) Receiving binary and analog signals from the field and providing command output to MCC/SWGR/Drive etc. through Input / Output modules and operator initiated commands from HMIS / control panel. c) Implementing all logic functions for control, protection and annunciation of the equipment and systems. d) Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data
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<p>etc.</p> <p>e) Performing self-monitoring and diagnostic functions</p> <p>2.2</p> <p>2.3</p> <p>2.4</p> <p>2.4.1</p> <p>2.5</p> <p>2.6</p> <p>3.0</p>	<p>PLC unit shall be provided with two processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete plant operation automatically. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor.</p> <p>The memory shall be field expandable. The memory capacity shall be sufficient for the complete system operation and have a capability for at least 20% expansion in future. Programmed operating sequences and criteria shall be stored in nonvolatile semiconductor memories like EPROM. All dynamic memories shall be provided with buffer battery backup for at least 360 hours. The batteries shall be lithium or Ni-Cd type.</p> <p>Priority of different commands shall be as follows:</p> <p>Manual intervention shall be possible at any stage of operation. Protection commands shall have priority over manual commands and manual commands shall prevail over auto commands.</p> <p>A forcing facility shall be provided for changing the states of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements. It shall be possible to display the signal flow during operation of the program.</p> <p>The SCADA shall be OPC version 2.05a compliant and implement a OPC-DA 2.05a server as per the specification of OPC Foundation. All data should be accessible through this OPC server. SCADA shall have OPC connectivity for other systems.</p> <p>HUMAN MACHINE INTERFACE SYSTEM (HMIS)</p> <p>Graphical Interface Unit (GIU) / Operator work station (OWS) shall perform control, monitoring and operation of all devices interacting with PLC based control system. It shall be possible to use the same as programming station of the PLC and the Human Machine Interface System. In case the PC based OWS cannot be used as programming station of the PLC and the Human Machine Interface System, then separate PC based programming station shall be provided.</p>
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	<p>Operator shall be able to access all control/information related data under all operating conditions including a single processor/computer failure in the HMIS. All frequently called important functions including major displays shall be assigned to dedicated function keys on a soft keyboard for the convenience of the operator for quick access to displays & other operator functions.</p> <p>The operator functions for each OWS / GIU shall have provision to be configured for Control System operation (A/M selection, raise/lower, set point/bias change, on/off, open/close operation, mode/device selection, bypassing criteria, sequence auto, start/stop selection, drive auto selection, local-remote/other multi-position selection etc.); alarm acknowledge; call all kind of displays, logs, summaries, calculation results, etc.; printing of logs & reports; retrieval of historical data; and any other functions required for smooth operation, control & management of information as finalized during detailed engineering.</p> <p>The display selection process shall be optimized so that the desired display can be selected with the minimum no. of operations. Navigation from one display to any other should be possible efficiently through paging soft keys as well as through targets defined on the displays. There should be no limitation on number of such targets.</p> <p>The system shall have built-in safety features that will allow/disallow certain functions and entry fields within a function to be under password control to protect against inadvertent and unauthorized use of these functions. Assignment of allowable functions and entry fields shall be on the basis of user profile. The system security shall contain various user levels with specific rights as finalized by the Employer during detailed engineering. However, no. of user levels, no. of users in a level and rights for each level shall be changeable by the programmer (Administrator).</p> <p>Wherever Graphical Interface Unit is envisaged, it shall meet the minimum functional requirements of monitoring, operating & controlling the process and displaying information related to process locally. GIU shall be provided with TFT active matrix display and keypad for operation. GIU shall be ruggedly designed to withstand hard environments like high temperature, shock and vibration.</p> <p>SCADA Software shall allow modifying dimensions of the SCADA screens without redrawing graphics</p> <p>Remote monitoring of essential parameters on the web using standard modem (Internet connection for transferring data to web shall be taken by Contractor in the name of NTPC Site for O & M period).</p>			
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4.0	Bidder has to provide suitable hardware and software based firewall for network security to restrict unauthorized access to HMI/Solar SCADA PCs and system.			
	PROGRAMMING FUNCTIONALITIES Programming of the PLC Processor / controller as well as programming of HMIS shall be user friendly with graphical user interface and shall not require knowledge of any specialized language. For example, the programming of PLC shall use either of the following:- <ul style="list-style-type: none">- Flow-chart or block logic representing the instructions graphically.- Ladder diagrams. The programming of HMIS (like development and modification of data base, mimics, logs / reports, HSR functionalities etc.) shall also be possible through user-friendly menus etc All programming functionalities shall be password protected to avoid unauthorized modification.			
5.0	SOFTWARE REQUIREMENT All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The contractor shall provide sufficient documentation and program listing so that it is possible for the Employer to carry out modification at a later date. The Contractor shall provide all software required by the system for meeting the intent and functional/parametric requirements of the specification. Industry standard operating system like WINDOWS (latest version) etc. to ensure openness and connectivity with other system in industry. SCADA system shall support following standard protocols (included but not limited to) to communicate with different sub system/Devices. <ul style="list-style-type: none">a) Modbus (TCP/IP, RTU, ASCII)b) Sub Station Protocol like IEC-61850c) IEC 60870 -5-101//104d) Any other protocol on which the offered equipment (by Contractor) will communicate with SCADA			
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The system shall have user friendly programming language & graphic user interface.

All system related software including Real Time Operating System, File management software, screen editor, database management software. On line diagnostics/debug software, peripheral drivers software and latest versions of standard PC-based software and latest WINDOWS based packages etc. and any other standard language offered shall be furnished as a minimum.

All application software for PLC system functioning like input scanning, acquisition, conditioning processing, control and communication and software for operator interface of monitors, displays, trends, curves, bar charts etc. Historical storage and retrieval utility, and alarm functions shall be provided.

The Contractor shall provide software locks and passwords to Employer's engineers at site for all operating & application software so that Employer's engineers can take backup of these software and are able to do modifications at site.

6.0
PARAMETRIC REQUIREMENTS

The control system shall be designed such that under worst case loading conditions the response time shall not be worst than the following:-

On/Off Command	-	The response time for screen update after the execution of the control command from the time the command is issued shall be two seconds (excluding the drive actuation time).
Adjustment Command	-	0.5 to 1 second.
On screen Updating	-	1 second.
All Control related displays	-	1 second.
Bar Chart displays	-	2 to 3 seconds.
Plant Mimic displays	-	2 to 3 seconds.

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	Group review displays	-	2 to 3 seconds.
	X-T Plot Displays	-	1 to 2 seconds.
	Plant Summary Displays	-	1 to 2 seconds.
Even under worst case loading condition of HMIS and system Bus, each HMIS processor shall have 50 % spare time when measured over any one minute period and the system bus shall have at least 50 % spare duty cycle.			

7.0

INPUT/OUTPUT MODULES

The PLC system should be designed according to the location of the input/output cabinets as specified.

Input Output modules, as required in the Control System for all type of field input signals (4-20 mA, non-changeover/change over type of contact inputs etc.) and outputs from the control system (non change over/change over type of contact, output signals for energizing interface relays at suitable DC voltage as decided during detail engineering, 4-20 mA output etc.) are to be provided by the Contractor

Electrical isolation of 1.5kV with optical couplers between the plant input/output and controller shall be provided on the I/O cards. The isolation shall ensure that any inadvertent voltage or voltage spikes (as may be encountered in a plant of this nature) shall not damage or mal-operate the internal processing equipment.

The Input/output system shall facilitate modular expansion in fixed stages. The individual input/output cards shall incorporate indications on the module front panels for displaying individual signal status.

Individually fused output circuits with the blower fuse indicator shall be provided. All input/output points shall be provided with status indicator. Input circuits shall be provided with fuses preferably for each input, alternatively suitable combination of inputs shall be done and provided with fuses such that for any fault, fuse failure shall affect the particular drive system only without affecting other systems.

All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching of power supply.

The I/O Module shall have the following features:

a	Power supply monitoring.
b	Contact bounce filtering.
c	Optical isolation between input and output signals with the internal circuits

- | | |
|---|---|
| d | In case of power supply failure or hardware fault, the critical outputs shall be automatically switched to the fail-safe mode. The fail-safe mode shall be finalized during detailed engineering. |
|---|---|

Binary Output modules shall be rated to switch ON/OFF coupling relays of approx. 3 VA. Analog output modules shall be able to drive a load impedance of 500 Ohms minimum.

Output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays etc. without any extra hardware.

All input field interrogation voltage shall be finalized during detail engineering

In case of loss of I/O communication link with the main processing unit, the I/O shall be able to go to predetermined fail safe mode (to be finalized during detailed engineering) with proper annunciation.

Contractor shall provide the I/Os modules at main control room/Inverter room for followings as the minimum(included but not limited to):

1. Analog Input Module
 - a. WTI, OTI of all the transformer of capacity more than 50 KVA.
 - b. Ambient Temperature --- 02 Nos
 - c. Module Temperature-----01 Nos at each Inverter block
 - d. Meteorological Parameters (Wind speed, GHI, Relative humidity etc.)
2. Binary Input Module
 - a. All the LT incomer breaker and bus coupler breaker
 - b. All the MV/HV/EHV breaker (as applicable)
 - c. Bucholz , WTI, OTI , PRV, MOG of all the Transformer
 - d. Other devices as included during the detailed engineering.
3. Binary Output Module:
 - a. All the LT incomer breaker and bus coupler breaker
 - b. All the MV/HV/EHV breaker (as applicable)

Contractor shall provide remote Input/output modules Housed cabinets/rack with suitable redundant data link to the central PLC system as specified. These Input/output modules shall meet the technical

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<p>8.0</p> <p>9.0</p>	<p>requirements as mentioned in the above clauses. Further these Input/output modules shall be designed to continuously work under the environment expected to be encountered in assigned areas without any air-conditioning support.</p> <p>SYSTEM SPARE CAPACITY</p> <p>Over and above the equipment and accessories required to meet the fully implemented system as per specification requirements, Control System shall have spare capacity and necessary hardware/ equipment/ accessories to meet following requirement for future expansion at site:</p> <p>10% spare channels in input/output modules fully wired up to cabinets TB shall be provided.</p> <p>Further, each processor / controller shall have spare capacity to handle minimum 30% additional inputs/ outputs of each type including above specified spare requirements, over and above implemented capacity. Each of the corresponding communication controllers shall also have same spare capacity as that of processor/controller. The Data communication system shall have the capacity to handle the additions mentioned above.</p> <p>Twenty (10) percent spare relays of each type and rating to be mounted and wired in cabinets TB. All contacts of relays shall be terminated in terminal blocks of cabinets.</p> <p>The spare capacity as specified above shall be uniformly distributed throughout all cubicles. The system design shall ensure that above mentioned additions shall not require any additional controller/processor/ peripheral drivers in the system delivered at site. Further, these additions shall not deteriorate the system response time / duty cycle, etc. from those stipulated under this specification.</p> <p>DATA COMMUNICATION SYSTEM (DCS) AT MAIN CONTROL ROOM</p> <p>The Data Communication System shall include a redundant Main System Bus with hot back-up. Other applicable bus systems like cubicle bus, local bus, I/O bus etc shall be redundant except for backplane buses which can be non-redundant.</p> <p>The DCS shall have the following minimum features :</p> <p>b The design shall be such as to minimize interruption of signals. It shall</p>		
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10.0	<p>ensure that a single failure anywhere in the media shall cause no more than a single message to be disrupted and that message shall automatically be retransmitted. Any failure or physical removal of any station/module connected to the system bus shall not result in loss of any communication function to and from any other station/module.</p> <p>c If the system bus requires a master bus controller philosophy, it shall employ redundant master bus controller with automatic switchover facility.</p> <p>d Built-in diagnostics shall be provided for easy fault detection. Communication error detection and correction facility (ECC) shall be provided at all levels of communication. Failure of one bus and changeover to the standby system bus shall be automatic and completely bump less and the same shall be suitably alarmed/logged.</p> <p>e The design and installation of the system bus shall take care of the environmental conditions as applicable.</p> <p>f Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc. plus 25% spare capacity shall be available for future expansion.</p> <p>g Contractor shall employ redundant Fibre optic backbone (Ring topology or better) for data communication between Inverter rooms and main control room. .</p> <p>The Contractor shall furnish details regarding the communication system like communication protocol, bus utilization calculations etc.</p>			
	<p>OPERATOR INTERFACE DISPLAYS/LOGS/REPORTS</p> <p>Suitable Operator Interface Displays/Logs/Reports for control operation & monitoring shall be provided. The details shall be finalized during detailed Engg. stage.</p> <p>Minimum quantities shall be as follows:-</p> <p>Various displays on the OWS shall as a minimum include P&ID displays or mimic, bar chart displays, X-Y & X-T plot (trend) displays, operator guidance message displays, group displays, plant start-up/shutdown message displays, system status displays etc. Number of displays and the exact functionality shall be on as required basis and as finalized during detailed engineering subject to the minimum quantities as given in subsequent clauses. For X-T & X-Y plots, the facility of providing a</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-C	Page 143 of 415

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	<p>background grid on operator request shall be variable with adequate no. Of divisions in both co-ordinates</p> <p>1 The minimum quantity of major types of displays per unit shall be as follows:</p> <table border="0"> <tr> <td>a) Control displays (group/sub-group/ sequence/loop)</td><td>(On as reqd. basis subject to 100 minimum)</td></tr> <tr> <td>b) P&ID/ mimic display</td><td>20</td></tr> <tr> <td>c) X-Y Plot (with superimposed operating curves + using user selectable stored data)</td><td>25 + 25</td></tr> <tr> <td>d) Group displays</td><td>20</td></tr> <tr> <td>e) Operator guidance message</td><td>10</td></tr> <tr> <td>f) System status & other diagnostic display</td><td>on as required basis</td></tr> </table> <p>The assignment for the above will be done by the contractor as per the requirement of operation of contractor's system as well as for maintenance. The balance displays shall be left as spare for future modification/addition.</p>	a) Control displays (group/sub-group/ sequence/loop)	(On as reqd. basis subject to 100 minimum)	b) P&ID/ mimic display	20	c) X-Y Plot (with superimposed operating curves + using user selectable stored data)	25 + 25	d) Group displays	20	e) Operator guidance message	10	f) System status & other diagnostic display	on as required basis
a) Control displays (group/sub-group/ sequence/loop)	(On as reqd. basis subject to 100 minimum)												
b) P&ID/ mimic display	20												
c) X-Y Plot (with superimposed operating curves + using user selectable stored data)	25 + 25												
d) Group displays	20												
e) Operator guidance message	10												
f) System status & other diagnostic display	on as required basis												
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11.0	<p>Historical storage and retrieval system (HSRS)</p> <p>The HSRS shall collect, store and process system data from MMIPIS data base. The data shall be saved online on hard disk and automatically transferred to erasable long term storage media once in every 24 hours periodically for long term storage. Provision shall be made to notify the operator when hard disk is certain percentage full. The disk capacity shall be sufficient to store at least seven days data.</p> <p>The data to be stored in the above system shall include alarm and event list, periodic plant data, selected logs/reports. The data/information to be stored & frequency of storage and retrieval shall be as finalised during detailed engineering. The system shall provide user-friendly operator functions to retrieve the data from historical storage. It shall be possible to retrieve the selected data on OWS or printer in form of trend/report by specifying date, time & period. Further, suitable index files/directories shall also be provided to facilitate the same. The logs/reports for at least last seven (7) days shall be available on the disk.</p> <p>In addition to above, the system shall also have facility to store & retrieve important plant data for a very long duration (plant life) on portable long term storage media). These data will include any data from the database as well as processed/computed data based a various calculations/transformation. The retrieved data from long term storage media should be possible to be presented in form of alarms, logs, reports, etc.</p>			
12.0	<p>CONTROL & POWER SUPPLY SCHEME</p> <p>Contractor shall provide the UPS/DC Power supply of suitable rating to cater all the load requirements of SCADA system and its auxiliaries. The details of UPS and its batteries are mentioned in the respective clause of this specification. The power backup for the entire system should be at least for 02 hours.</p>			
13.0	<p>CONTROL CABINETS / PANELS / DESKS AT CMCS ROOM</p> <p>The cabinets shall be IP-22 protection class. The Contractor shall ensure that the packaging density of equipment in these cabinets is not excessive and abnormal temperature rise, above the cabinet temperature during normal operation or air-conditioning failure, is prevented by careful design. This shall be demonstrated to the Employer during the factory testing of the system. The Contractor shall ensure that the temperature rise is limited to 10 deg. C above ambient and is well within the safe limits for system components even under the worst condition and specification requirements</p>			
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for remote I/O cabinets. Ventilation blowers shall be furnished as required by the equipment design and shall be sound proof to the maximum feasible extent. If blowers are required for satisfactory system operation, dual blowers with blower failure alarm shall be provided in each cabinet with proper enclosure and details shall be furnished with proposal. Suitable louvers with wire mesh shall be provided on the cabinet.

The cabinets shall be designed for front access to system modules and rear access to wiring and shall be designed for bottom entry of the cables.

The cabinets shall be totally enclosed, free standing type and shall be constructed with minimum 2 mm thick steel plate frame and 1.6 mm thick CRCA steel sheet or as per supplier's standard practice for similar applications, preferred height of the cabinet shall not higher than 2200 mm. The cabinets shall be equipped with full height front and rear doors. The floor mounting arrangement for other cabinets shall be as required by the Employer and shall be furnished by the Contractor during detailed engineering.

Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is more than 800 mm, double doors shall be provided.


Two spray coats of inhibitive epoxy primer-surface shall be applied to all exterior and interior surfaces. A minimum of 2 spray coats of final finish colour shall be applied to all surfaces. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2 mm and 50 microns for sheet thickness of 1.6 mm. The finish colors for exterior and interior surfaces shall conform to following shades:

(a.) Exterior:- As per RAL 9002 (End panel sides RAL 5012), to be finalized during detailed engineering.

(b.) Interior:- Same as above.

Paint films which show sags, checks or other imperfections shall not be acceptable.

As an alternative, single coat of anodic dipcoat primer along with single textured powder coating with epoxy polyester meeting the thickness requirement is also acceptable.

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14.0	<p>The mimic shall be configured on the HMI and it shall be possible to control, monitor and operate the plant from the same.</p>			
	<p>CONTROL DESK</p> <p>Control desk shall be free standing table top type with doors at the back and shall be constructed of 3 mm thick CRCA steel plates. A 19 mm thick wooden top shall be provided on the desk to keep the TFT monitors at top and computers inside. Control desk shall consist of vertical, horizontal and base supports with their coverings for work surface, keyboard trays, mouse pads, monitor shelf and concealed cable and wire way management, perforated trays with covers in both horizontal and vertical directions. Telephone sets, very few PB stations and lamps shall be mounted on the control desk on mosaic grid structure and same shall be decided during detailed engineering. ASCII Keyboard shall be capable of being pulled out through a tray.</p> <p>The cabling / wiring between EWS/OWS & CPU’S, power supply cables etc. shall be aesthetically routed and concealed from view.</p>			
15.0	<p>FURNITURE</p> <p>Chairs – Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge & other personnel in control room area (At least 4 Nos). These shall be designed for sitting for long duration such that these are comfortable for the back. Chair pedestal shall be made of 5mm thick MS plate covered with poly-propylene cladding. Arm-rests in one piece shall be of poly-urethane and twin wheel castor of glass filled nylon. The exact details shall be finalized & approved by Employer during detailed engineering.</p>			
	16.0	<p>SOFTWARE DOCUMENTATION AND SOFTWARE LISTINGS</p> <p>All technical manuals, reference manuals, user’s guide etc., in English required for modification/editing/addition/deletion of features in the software of the PLC System shall be furnished. The Contractor shall furnish a comprehensive list of all system/application software documentation after system organization for Employer’s review and approval.</p> <p>All The software listings for application software, Project data files etc. shall be submitted by the Contractor.</p>		
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CLAUSE NO.	TECHNICAL SPECIFICATIONS		
<p>17.0</p> <p>18.0</p> <p>19.0</p>	<p>SOFTWARE LICENCES</p> <p>The Contractor shall provide software license for all software being used in Contractor's System. The software licenses shall be provided for the project (e.g. organization or site license) and shall not be hardware/machine-specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for Employer to seek a new license/renew license due to up gradation/change of hardware/machine in Contractor's System at site. All licenses shall be valid for the continuous service life of the plant.</p> <p>Contractor shall provide Minimum 4 nos of licenses for remote monitoring (Concurrent viewing of data at 4 different locations authorised with user ID/Password) of the essential parameters of solar plant on the web using popular web browser without requirement of additional software</p> <p>TIME SYNCHRONIZATION AND INTERFACE WITH PI SERVER</p> <p>The contractor will provide at least one GPS time synchronizing unit ,, which shall be synchronized with the SCADA system and all devices which are communicating with Solar SCADA shall be synchronized with GPS time synchronizing unit. The technical details of GPS have been specified elsewhere in the specification.</p> <p>For communicating the generation data of solar plant in NTPC, the SCADA system shall be interfaced/ connected with PI server of NTPC. The details of PI server shall be furnished during the detailed engineering.</p> <p>HMIPIIS HARDWARE AT MAIN CONTROL ROOM</p> <p>The HMIPIS as specified shall be based on latest state of the art Workstations and Servers and technology suitable for industrial application & power plant environment.</p> <p>The Workstation/Servers employed for HMIPIS implementation shall be based on industry standard hardware and software which will ensure easy connectivity with other systems and portability of Employer developed and third party software.</p> <p>Redundant sets of communication controllers shall be provided to handle all the communication between the HMIPIS and redundant system bus and to ensure specified system response time and parametric requirements. Each communication controller shall have message checking facility.</p>		
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Power Fail Auto Restart (PFAR) facility with automatic time update shall be provided.

All the peripherals shall conform to the following minimum requirement but the exact make & model shall be as approved by Employer during detailed engineering. The LAN to be provided under HMIPIS shall support TCP/IP protocol (Ethernet connectivity) with OPC RDI for interface with PLCs/other systems and shall have data communication speed of min. 100 MBPS. All network components of LAN and Workstations shall be compatible to the LAN, without degrading its performance.

Workstations (Qty- 2Nos)

Sl No.	Features	Operator workstations/ Other workstations/ Documentation station (in case not part of prog. Stn.)
1.	Processor	64 bit
2.	Memory	4 GB RAM upgradable to 8 GB
3.	Hard Disk	500 GB RAID1
4.	Monitor (color)	Min 22" TFT Flat Monitor with non-interfaced refresh rate min. 75 Hz. Communication port:- 2 Serial bus , one parallel Dual 10/100/1000 Mbps. Ethernet Graphic Memory = 16 MB Expansion slot=3
5.	Removable bulk storage drive (DVD / DAT)	6 GB (minimum)
6.	Removable Bulk Storage Media for above (with each server/work-station)	10 nos
7.	DVD R/W	16x or higher

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8.	Intelligent UPS (on line) with remote monitoring for each workstation/ server	1 no. with 30 mins. Battery backup on machine load
9.	Keyboard	ASCII
10.	Pointing Device	Mouse
11.	Accessories	Industrial grade furniture as approved during detailed engineering
12.	Additional general purpose software (for using over network by servers/workstations/PCs)	Comprehensive disk maintenance utility for disk clean sweep/ crash guard/antivirus, etc.
13.	Software	Ms. Windows latest, Ms Office, Adobe Acrobat, Anti Virus. Etc.
14.	LED	40 " WALL MOUNTABLE OF LEADING BRANDS LIKE Sony, Samsung, LG etc.

Printer (Qty- 1 No.)

Sr	Features	Colour Laser Printer
1	Paper Size	A3
2	Printing Speed (min.)- in normal mode for A4 size paper	6 ppm (Color) 24 ppm (B&W)
3	Type	Heavy duty, at least 50000 pages/month
4	Resolution (black) (min.)	600 dpi

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5	First page out time (with full graphic display)	=<1 min for color,
		<45 sec for BW
6	Paper input capacity (min.)	500 sheets
7	Additional features	Automatic Duplex Printing
8	Paper sheets (1 ream = 500 sheets) with each printer	20 reams (A3)
		20 reams (A4)

20.0

FACTORY ACCEPTANCE TEST (FAT)

FAT procedure shall be submitted by bidder for NTPC approval and after approval of FAT procedure. FAT will be witnessed by NTPC Engineering or authorized representative of NTPC. SCADA shall communicate with all third party devices which are part of Solar Plant and the same shall be demonstrated during the FAT.

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
1.0	C-8)INSTRUMENTATION AND COMMUNICATION CABLE			
	COMMUNICATION CABLE (Optic Fibre Cable) <p>Optic Fiber cable shall be 4/8/12 core, galvanized corrugated steel taped armoured, fully water blocked with dielectric central member for outdoor/indoor application so as to prevent any physical damage. The cable shall have multiple single-mode or multimode fibers on as required basis so as to avoid the usage of any repeaters. The core and cladding diameter shall be 9 +/-1 micrometer and 125 +/- 1 micrometer respectively. The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturing, progressive automatic sequential on-line marking of length in meters at every meter on outer sheath.</p> <p>The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Steel central number, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with Thixotropic jelly etc. The cable shall be suitable for maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum & crush resistance 4000 N minimum. The operating temperature shall be -20 deg. C to 70 deg. C.</p> <p>All testing of the optic fiber cable being supplied shall be as per the relevant IEC, EIA and other international standards.</p> <p>Bidder to ensure that minimum 100% cores are kept as spare in all types of optical fiber cables.</p> <p>Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground buried installation.</p> <p>Spliced/ Repaired cables are not acceptable.</p> <p>Penetration of water resistance and impact resistance shall be as per IEC standard.</p>			
1.1	Communication Cable (Modbus) <p>Data (Modbus) Cable to be used shall be shielded type with stranded copper conductor based on VDE 0881. Cable shall have minimum 2 pair each with conductor size of 0.5 SQMM and core identification shall comply with DIN 47100. Cable shall be flame retardant according to IEC 60332-1-2. Cable shall be tested for Peak working voltage of not less than 300 V</p>			
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and shall be suitable for serial interfaces (RS 422 and RS 485). The cable shall be provided with lightning and surge protection devices as per EN 61643-21. Surge protection device to be provided shall be approved from UL/CSA or any national/international approved lab.

2.0
Instrumentation Cables
2.1
Common Requirement

S No.	Property	Requirement
1.	Voltage grade	225 V (peak value)
2.	Codes and standard	All instrumentation cables shall comply with VDE 0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472, SEN 4241475, ANSI MC 96.1, IS-8784, IS-10810 (latest editions) and their amendments read along with this specification.
3.	Continuous operation suitability	At 70 deg. C for all types of cables
4.	Progressive automatic on-line sequential marking of length in meters	To be provided at every one meter on outer sheath.
5.	Marking to read 'FRLS	To be provided at every 5 meters on outer sheath
6.	Allowable Tolerance on overall diameter	+/- 2 mm (maximum) over the declared value in data sheet
7.	Variation in diameter	Not more than 1.0 mm throughout the length of cable.
8.	Ovality at any cross-section	Not more than 1.0 mm
9.	Others	a) Durable marking at intervals not exceeding 625 mm shall include manufacturer's name, insulation material, conductor's size, number of pairs, voltage rating, type of cable, year of manufacturer to be provided. b) Cables shall be suitable for laying in conduits, ducts,

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		trenches, racks and underground-buried installation c) Repaired cables shall not be acceptable.
10.	Color	The outer sheath shall be of blue Blue

2.2

Specific Requirement

S No.	Property	Requirement
	Type of Cable	F and G Type cables
A. Conductors		
1.	Cross section area	0.5 sq. mm
2.	Conductormaterial	HighconductivityAnnealed bare copper
3.	Colour code	As per VDE-815
4.	Conductor Grade	Electrolytic
5.	No & dia of strands	7x0.3 mm (nom)
6.	No. of Pairs	4,8,12,16,24,48
7.	Max. conductor resistance per Km (in ohm) at 20 deg. C	73.4 (loop)
8.	ReferenceStandard	VDE 0815
B. Insulation		
1.	Material	Extruded PVC type YI 3
2.	Thickness in mm (Min/Nom/Max)	0.25/0.3/0.35
3.	Volume Resistivity (Min) in ohm-cm	1 x 10 ¹⁴ at 20 deg. C & 1x10 ¹¹ at 70 deg. C.
4.	Reference	VDE 0207 Part 4
5.	Core diameter above insulation	Suitable for cage clamp connector
C. Pairing & Twisting		
1.	Single layer of binder tape on each pair provided	Yes
2.	Bunch(Unit formation) for more than 4P	To be provided

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3.		Conductor /pair identification as per VDE081	To be provided
D. Shielding			
1.		Type of shielding	Al-Mylar tape
2.		Individual pair shielding	To be provided for F-type cabl
3.		Minimum thickness of Individual pair shielding	28 micron
4.		Overall cable assembly shielding	To be provided
5.		Minimum thickness of Overall cable assembly shielding	55 micron
6.		Coverage Overlapping	100% coverage with 20% overlapping
7.		Drain wire provided for individual shield	Yes (for F-type) Size=0.5 mm ² , No.of strands=7, Dia of strands =0.3 mm ,Annealed Tin coated copper
8.		Drain wire provided for overall shield	Yes. Size=0.5 mm ² , No.of strands=7, Dia of strands=0.3mm Annealed Tin coated copper
E. FILLERS			
1.		Non-hygroscopic, flame retardant	To be provided
F. Outer Sheath			
1.		Material	Extruded PVC compound YM1 with FRLS properties
2.		Minimum Thickness at any point	1.8 mm
3.		Nominal Thick-ness at any point	>1.8 mm
4.		Resistant to water, fungus, termite & rodent attack	Required
5.		Minimum Oxygen index as per ASTM D-2863	29%
6.		Minimum	250 deg.C

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		Temperature index as per ASTM-D-2863	
7.		Maximum acid gas generation by weight as per IEC-60754-1	20%
8.		Maximum Smoke Density Rating as per ASTM-D-2843	Maximum 60% To be provided (defined as the average area under the curve when the results of smoke density test plotted on a curve indicating light absorption vs. time as per ASTM-D-2843)
9.		Reference standard	VDE207 Part 5, VDE-0816
G. Electrical Parameters			
1.		Mutual Capacitance Between Conductors At 0.8 KHz (Max.)	120 nF/km for F type 100 nF/km for G-type
2.		Insulation Resistance (Min.)	100 M Ohm/Km
3.		Cross Talk Figure (Min.) At 0.8 KHz	60 dB
4.		Characteristic Impedance (Max) At 1 KHz	320 OHM FOR F-TYPE 340 OHM FOR G-TYPE
5.		Attenuation Figure At 1 KHz (Max)	1.2 db/km
H. Complete Cable			
1.		Complete Cable assembly	Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3.
2.		Flammability	Shall pass flammability as per IEEE-383 read in conjunction to this specification
I. Tests			

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1.		Routine & Acceptance tests	Refer Type Test requirement of Specification for C & I System
2.		Type tests	
J Cable Drum			
1.		Type	Returnable wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to the entire drum) or steel drum.
2.		Outermost layer covered with waterproof paper	Yes
3.		Painting	Entire surface to be painted
4.		Length	1000 m + 5% for up to & including 12 pairs 500 m + 5% for above 12 pairs

3.0

TYPE TEST

All cables to be supplied shall be of type tested quality. The Contractor shall submit for Owner's approval the reports of all the type tests and carried out within last five years from the date of bid opening. These reports should be for the tests 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.

In case the Contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval.

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C-9) EARTHING SYSTEM

1.0

AC SYSTEM

1.1

CODES AND STANDARDS

IS: 3043	Code of practice for Earthing.
IEEE: 80	IEEE guide for safety in AC substation grounding
IEEE: 142	Grounding of Industrial & commercial power systems
IS: 13947	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: 802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
IS: 2629	Recommended practice for hot dip galvanizing of iron & steel
IS: 2633	Method for testing uniformity of coating on zinc coated articles
IS: 513	Cold rolled low carbon steel sheets and strips
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: 4736	Hot-dip Zinc coating for MS Tubes.
IS: 458	Precast Concrete Pipes (With and Without Reinforcement)
	Indian Electricity Act.
	Indian Electricity Rules.

1.2

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 above standards/ codes as applicable.

TECHNICAL DETAILS

Earthing system shall be in strict accordance with IS: 3043 and Indian Electricity Rules/Acts.

For outdoor switchyard, Earthing system network/earthmat shall be interconnected mesh of mild steel rods buried in ground. For other areas in the solar plant such as transformer yard, switchgear room the earthing system shall consist of minimum two parallel conductors interconnected together. The Contractor shall furnish the detailed design and calculations for Employer's approval. Contractor shall obtain all necessary statutory approvals for the system.

The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects

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

The sizes of earthing conductors for various electrical equipments shall be as below:

S No.	Equipment	Earth Conduct buried in Earth	Earth conduc above ground level and built up trenches
1	Switchyard/Outdoor substation	40 mm dia. MS rod	65 x 8mm GS flat
2	33kV/11kV/6.6kV/3.3 switchgear equipment and 415V switchgear	65 x 8mm GS flat	65 x 8mm GS flat

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3	415 V MCC/ Distribution boards / Transformers	65 x 8mm GS flat	50 x 6mm GS flat
4	LT Motors above 125 KW	65 x 8mm GS flat	50 x 6mm GS flat
5	LT Motors 25 KW to 125 KW	65 x 8mm GS flat	25 x 6mm GS flat
6	LT Motors 1 KW to 25 KW	65 x 8mm GS flat	25 x 3mm GS flat
7	Fractional House power motor	65 x 8mm GS flat	8 SWG GS wire
8	Control panel & control d	65 x 8mm GS flat	25 x 3 mm GS flat
9	Push button station Junction Box	65 x 8mm GS flat	8 SWG GI wire
10	Columns, structures, cable trays and bus ducts enclosures	65 x 8mm GS flat	50 x 6mm GS flat
11	Crane, rails, rail tracks & Other non-current carrying metal parts	65 x 8mm GS flat	25 x 6mm GS flat

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. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable.

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.

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.

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	<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> <p>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.</p> <p>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.</p> <p>Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.</p> <p>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.</p> <p>Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.</p> <p>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.</p> <p>Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.</p> <p>Earth pit 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 if average resistance of soil is more than 20 ohm meter. However Based on the soil resistivity data of the site, in case, the earthing resistance requirements as per applicable standard is not met, bidder may have to provide special earthing arrangement like chemical earthing etc in order to</p>			
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1.3	<p>meet the earthing resistance requirements. For chemical earthing, compound shall have pH between 6-8. It shall be used with compatible electrode (cu, cu bonding) as per guidelines of compound manufacturer. It shall not shrink or expand over the period of time and shall be maintenance free.</p> <p>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.</p> <p>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.</p> <p>Other Requirements of Earthing System:</p> <table border="0"> <tr> <td>Standard/Code</td><td>IEEE 80, IS 3043</td></tr> <tr> <td>Earthing System</td><td></td></tr> <tr> <td>Life expectancy</td><td>40 Years</td></tr> <tr> <td>System Fault Level</td><td>As per system requirement</td></tr> <tr> <td>Soil resistivity</td><td>Actual as per site conditions.</td></tr> <tr> <td>Min. Steel corrosion</td><td>0.12mm/year</td></tr> <tr> <td>Depth of burial of main earth conductor</td><td>600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.</td></tr> <tr> <td>Conductor joints</td><td>By electric arc welding, with resistance of joint not more than that of the conductor.</td></tr> <tr> <td>Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.</td><td></td></tr> <tr> <td>Surface resistivity</td><td>- Gravel 3000 ohm-meter - Concrete 500 ohm-meter</td></tr> </table>	Standard/Code	IEEE 80, IS 3043	Earthing System		Life expectancy	40 Years	System Fault Level	As per system requirement	Soil resistivity	Actual as per site conditions.	Min. Steel corrosion	0.12mm/year	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
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<p>2.0</p> <p>2.1</p> <p>2.2</p> <p>2.3</p> <p>2.4</p> <p>2.5</p>	<p>SOLAR ARRAY EARTHING</p> <p>Each Module mounting structure (MMS), SPV Module frames, mounting arrangement for String Monitoring Boxes, Metallic Junction Boxes, Metal frames/Panel, Metallic Pipes of the solar array shall be effectively earthed by two separate and distinct connections to earthing system. Earthing system for solar array shall consist of earth mat/Earth grid to be laid at the depth of 600 MM below the ground. Earth mat shall be a mesh of interconnected Galvanizing Steel (GS) flat laid in the solar farm for the purpose of earthing/grounding. Equipment and structure in the solar farm shall be earthed in compliance to the IS: 3043 (Code of Practice for Earthing) and Indian Electricity Rules/Acts.</p> <p>The Contractor shall furnish the detailed design and calculations for Owner's approval as per IEEE80-2000 to determine the number of earth pit and size of earth mat conductor. However the No. of earth pits for the solar farm shall not be less than nos. of Inverters selected for the Solar PV Project and size of earth mat conductor shall not be less than 25X6 GS flat. Minimum size of riser to connect the structures and JB etc. to the earth-mat in the solar farm shall be 25X3 GS Flat. Location of earth pits and laying of earth conductor shall be decided during detail engineering.</p> <p>System Requirement for the solar array:</p> <table> <tr> <td>Life Expectancy</td><td>25 Years</td></tr> <tr> <td>System fault level</td><td>As per system requirement</td></tr> <tr> <td>Soil resistivity</td><td>Actual as per site conditions</td></tr> <tr> <td>Min. Steel corrosion</td><td>0.12mm/year</td></tr> <tr> <td>Earth Conductor joints</td><td>By electric arc welding, with resistance of joint not more than that of the conductor</td></tr> </table> <p>Connection of riser to the structures shall be bolted or welded type. Portion of galvanised structure which undergoes welding at site shall be coated with two coats of cold galvanising and anti-corrosion paint afterwards. .</p> <p>Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection, 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.</p>	Life Expectancy	25 Years	System fault level	As per system requirement	Soil resistivity	Actual as per site conditions	Min. Steel corrosion	0.12mm/year	Earth Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor
Life Expectancy	25 Years										
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<p>2.6</p> <p>2.7</p> <p>2.8</p> <p>2.9</p> <p>2.10</p> <p>2.11</p> <p>2.12</p>	<p>Earth conductor shall be laid in the ground in manner that distance of any metallic part of the object to be earthed from the earth conductor is not more than 15 Meter. A continuous earth path is to be maintained throughout the PV array.</p> <p>Each PV Module frame shall be earthed in accordance with module manufacturer guidelines. In case module frame earthing is to be separately provided, it shall be earthed with minimum 2.5 sq. mm flexible copper cables with lug at suitable location of module frame. There shall not be more than 12 nos. of PV modules in single loop of earthing connection to module frame. Both ends of the loop of copper cable for earthing shall be connected with nearest earthed structure or earth conductor.</p> <p>Based on the design of detail engineering, contractor shall have to arrange additional earth pit as mentioned below:</p> <p>Earth pit for earthing of Inverter Transformer Shield. Number of shield earth pit shall be minimum two for each transformer. Shield earth pit shall be connected to inverter transformer shield bushing conductor with copper flat. Size of Cu flat shall be decided during detailed engineering but shall not be less than 25X6 Cu flat. Contractor has to comply with the guidelines of Inverter Transformer/Inverter manufactures (if any) for shield earthing.</p> <p>Electronic/Isolated earth pit for SCADA/Electronic devices. No. and location of electronic earth pit shall be decided during detailed engineering however minimum no. of electronic earth pit shall be equal to the total Nos. of inverter rooms, pooling switchgear/s and/or Main control room.</p> <p>Contractor shall seek owner's approval for connecting solar array earth mat with any other earth mat/earth grid of the solar PV plant.</p> <p>Earth pit 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 if average resistance of soil is more than 20 ohm meter.</p> <p>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.</p> <p>Size of earth conductor, nos. of earth pits given in this clause is applicable for solar array earthing only. Method and practice of laying of earthing conductor, earth pits and riser not mentioned herewith but given elsewhere in this specification is applicable to solar array earthing also.</p>
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C-10) LIGHTNING PROTECTION SYSTEM

Lightning protection system shall be in strict accordance with IS:2309 .

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

Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc. as per approved drawings.

1.0

DOWN CONDUCTORS

Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.

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.

All joints in the down conductors shall be welded type.

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.

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.

All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.


Lightning conductors shall not pass through or run inside GI Conduits.

Testing link shall be made of galvanized steel of size 25x 6mm.

Pulser system for lightning shall not be accepted for AC system.

Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths


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<p>2.0</p> <p>2.1</p> <p>2.2</p> <p>2.3</p>	<p>LIGHTNING PROTECTION SYSTEM FOR SOLAR ARRAY</p> <p>Codes and Standard</p> <p>IS : 2309 : Code of Practice for the protection of building and allied structures against lightning</p> <p>NF C 17-102 : Lightning Protection with Early Streamer Air Termination Rod</p> <p>Complete Solar Array with associated structure shall be protected from Direct Lightning Stroke. Lightning Protection for solar array shall be achieved with any or both of the following two systems as per specification provided in the following section.</p> <p>Single Rod Air Terminal (Faraday Rods)</p> <p>Early Streamer Emission (ESE) Air Terminal</p> <p>Suitable earthing and equipotential bonding shall be ensured for the air termination rods as per applicable standard/Equipment manufacturer guidelines.</p> <p>Current carrying parts and accessories such as clamps, fasteners, down conductor, Test links and earth termination etc. shall be preferably procured from OEM of Air Terminals if it is supplied by them as part of lighting protection system.</p> <p>LIGHTNING PROTECTION SYSTEM FOR SOLAR ARRAY WITH SINGLE ROD AIR TERMINAL</p> <p>Solar array of plant shall be protected from direct lightning strike with straight or angled air termination rods of suitable class as per IS:2309 to be fixed with the module mounting structure (MMS). Air termination rods shall have minimum two clamps to be fixed with MMS and must be capable of carrying full lightning current. Contractor to ensure proper fixing of the clamps with MMS to allow lightning current to pass through the clamp without damage and to sustain the rods during high velocity wind.</p> <p>Contractor shall submit the calculation to determine the no. and location of air termination rods to be fixed on structure to provide the lightning protection to each solar module and structure.</p> <p>Earth riser shall be connected to that part/pole of MMS which is nearest to air termination rod.</p>
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2.4	LIGHTNING PROTECTION SYSTEM FOR SOLAR ARRAY WITH E.S.E AIR TERMINAL			
	<p>Solar array shall be protected from direct lightning stroke with Early Streamer Emission air terminal in accordance to NF C 17-102 (Latest revision).</p> <p>Location and layout of ESE terminal shall be in such a manner that it cast no shadow on the PV Modules during 08:30 AM to 04:30 PM. Number and location of ESE air terminal shall be decided during detail engineering. For this purpose, design calculation and Autocad drawing of the layout of ESE terminal shall be submitted to NTPC for approval.</p> <p>ESE air terminal shall be type tested in any national/international approved lab for advance triggering time (ΔT) and lighting Impulse current test and type test report shall be submitted to NTPC for approval.</p> <ul style="list-style-type: none">i. Each ESE air terminal shall be provided with separate earthing termination and test link for equipotential bonding of lightning protection system as per OEM guidelines/NFC 17 -102. Each ESE air terminal shall be equipped with lightning stroke counter to be fixed at suitable height in serial on the down conductor.ii. ESE air terminal shall be erected on isolated foundation to be approved by NTPC. If required, Suitable guy wire shall be used to support the mast of ESE terminal against the wind.			
2.5	LIGHTNING PROTECTION SYSTEM FOR INVERTER ROOM AND CMCS ROOM			
	<p>Bidder needs to provide the lightning protection for each inverter, Switchyard building (if applicable) and CMCS building in accordance to IS:2309.</p>			
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	<p style="text-align: center;">C-11) PLANT ILLUMINATION SYSTEM</p> <p>This chapter covers supply and installation of suitable illumination system along the peripheral roads, control room, inverter room(s), switchyard and other facilities inside the plant.</p> <p>1.0 DESIGN PHILOSOPHY</p> <p>A comprehensive illumination system shall be provided in the entire project. Each building shall be provided with adequate light fittings, 6A/16A socket, fans, etc. Exhaust fans shall also be provided in toilets, battery room, etc</p> <p>All outdoor lighting system shall be automatically controlled by synchronous timer or photocell. Provision to bypass the timer or photocell shall be provided in the panel.</p> <p>2.0 LIGHTING SYSTEM DESCRIPTION FOR CMCS AND INVERTER ROOM</p> <p>Normal AC Lighting System: AC lighting system 415V, 3Phase, 4wire, will be fed from lighting panels Control Board (LPs) which in turn will be fed from the lighting distribution boards (LDBs) of AC Switch board MCC.</p> <p>Emergency AC Lightning System: The emergency lighting system consisting of 20% of the lights shall be fed from UPS DB or DCDB as per scheme adopted by the EPC bidder. Load of the same has to be considered for UPS/ Battery and charger sizing.</p> <p>3.0 Lighting Fixture, Lamps & Accessories</p> <ol style="list-style-type: none"> All lighting fixtures and accessories shall be designed for continuous operation for its life under atmospheric conditions existing at site. AC lighting fixtures and accessories shall be suitable for operation on 240 V, AC, 50 Hz supply with supply voltage variation of +/-10%, frequency variation of +/- 5% and combined voltage and frequency variation (absolute sum) of 10% DC lighting fixtures and accessories shall be suitable for operation on 220 V, with variation between 190 V & 240 V. All lighting fixtures shall be complete with lamp(s), lamp holder(s), LED chip assembly, terminal blocks, clamps, locking arrangements, fixing brackets etc. Driver circuit/Control gears shall be provided as applicable / specified. The fixtures shall be fully wired upto terminal block. The internal wiring of the fixtures shall be done with suitable low smoke halogen free thermo-plastic or silicon rubber insulated or fire retardant PTFE copper conductor wires of suitable size and type. 		
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4.0	<p>Further fuse protection of suitable rating in input side shall also be provided specifically for LED luminaires. However, the normal cross section of conductor shall be not less than 0.5 Sq. mm and minimum thickness of insulation shall be 0.6 mm. The wiring shall be capable of withstanding the maximum temperature to which it will be subjected under specified service conditions without deterioration and affecting the safety of the luminaire when installed and connected to the supply. All fixing /locking screws, washers, nuts, brackets, studs etc, shall be zinc plated and passivated.</p> <ul style="list-style-type: none"> d. All lighting fixtures shall be provided with an external, brass/GI earthing terminal suitable for connecting 14 SWG, GI earthing wire. All metal or metal enclosed parts of the housing and accessories shall be bonded and connected to the earthing terminal as so to ensure satisfactory earthing continuity through out the fixture e. The lighting fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection f. The reflectors shall be manufactured from CRCA sheet steel or aluminium as specified. The aluminium reflectors shall be made of high purity aluminium sheet, polished electrochemically brightened and anodized or proven alternate arrangement of anodizing g. Starters shall have bi-metal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without use of any tool. Starter shall have brass contacts and radio interference suppressing capacitor. h. LED luminaires body shall such designed that heat sink/heat dissipating housing shall be mounted outside the overall luminaires fixture housing, and shall be suitably clearing the driver circuit. Further for outdoor type LED luminaires, the exposed heat sink shall be suitably designed to avoid dust/foreign particles accumulation on the same. i. LED luminaires housing/body shall be pressure die cast aluminium or extruded Aluminium or CRCA as specified alongwith finished powder coating. Care shall be taken in the design that there is no water stagnation anywhere. <p>LED LUMINAIRES:</p> <p>4.1 CODES AND STANDARDS</p> <p>All standards and codes of practice referred to herein shall be the latest edition including all applicable official amendments & revisions as on date of techno-commercial bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the</p>			
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	former shall prevail. All work shall be carried out as per the following standards & codes.			
	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.	Supplied Electronic control gear for LED modules	
	16104:2012	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.		
	16106:2012	Method of Electrical and photometric Measurements of Solid State Lighting (LED) Products		
	16107:2012	Luminarie 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			
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		by enclosures.		
	IS 14700 (Part 3/Sec. 2)	Electro magnetic compatibility (EMC) – Limits 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 (Part 2/Sec. 13) IS 16004 – 1 and 2)	Lamp control gear: particular requirements for DC or AC supplied electronic control gear for LED modules.		
	IS 4905 IEC 60598	Method for random sampling Ingress protection, luminaire performance and safety		
	IEC 61000-3-2	Total Harmonic Distortion		
	IEC 61000-4-5	Surge Protection		
	IES-LM 80 along with TM 21/ IS 16105	Lumen Depreciation and Rated life of LED chip		
	IES-LM 79 / IS 16106	Luminaire optics and color parameter and electrical parameter		
	4.2 LED LIGHTING SYSTEM			
<p>LED Luminaires shall be used for the lighting of all the indoor & outdoor areas. However for DC lighting & hazardous areas conventional type luminaires shall be used. In false ceiling area LED luminaires shall be recessed 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 for outdoor type luminaires. However for indoor type luminaires fractional wattage LEDs are also acceptable. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall not be less than 80 Lm/W. Heat sink/heat dissipation arrangement shall be provided in the luminaires. 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 type LED luminaires. Further for outdoor type luminaires, the colour designation shall be 5000K, except for well glass type LED luminaires,</p>				
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	<p>where the colour designation shall be 4000K. The LED luminaires shall have minimum life of 25,000 burning hours with 80% of lumen maintenance at the end of the life.</p> <p>The beam angle for LED chip for indoor type luminaires shall be 120 degrees. However for highbay & flood light type outdoor luminaires the LED chip with suitable beam angle shall be used to deliver better lumen-output. The maximum junction temperature of bare LED without heat sink shall be limited to 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/ heat dissipation arrangement, with proper thermal management shall be designed for the luminaires.</p> <p>Driver Circuit: LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED manufacturer.</p> <p>LED Drivers may 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 <p>Lighting panels shall be powder coated with color shade RAL9002. Lighting panels shall have IP55 degree of protection.</p> <p>Wires of different phase shall normally run in separate conduit.</p> <p>Power supply shall be fed from 415 / 240 V normal AC supply through suitable number of conveniently located lighting distribution boards (LDB) and at least one 6/16A, 240V AC universal socket outlet with switch shall be provided in offices, cabins, etc.</p> <p>Suitable number of 63A, 3ph, 415V AC industrial receptacles shall be provided for welding purposes at one location.</p> <p>Incandescent lamps may be used only with DC Lighting.</p> <p>Electrification of all building shall be carried out as per IS 732-1989, IS 4648-1968 and other relevant standards.</p>		
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5.0	<p>Indoor Lighting fixtures shall generally be controlled from switch boxes of each area not directly from lighting panel. Each switch shall control a maximum of three fixtures.</p> <p>All luminaries and their accessories and components shall be of type readily replaceable by available Indian makes.</p> <p>Following test reports to be submitted for LED chip/LED luminaires:</p> <ol style="list-style-type: none"> LED parameters like Lumen per watt, CRI, Beam angle from manufacturer. LM 80/IS: 16105 report. LM 79/IS: 16106 report 			
	<p>JUNCTION BOXES, CONDUITS, FITTING & ACCESSORIES</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:</p> <p>Heavy duty PVC conduits conforming to IS: 9537 Part-III along with various accessories shall be used for indoor wiring in the buildings. These conduits shall be concealed in the wall/floor/roof. However, in PEB's, conduits can be fixed on surface.</p> <p>Pull out boxes shall be provided at suitable interval in a conduit run .Boxes shall be suitable for mounting on Walls, Columns, etc. Pull-out boxes shall have cover with screw. 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.</p> <p>6.0 LIGHTING WIRES</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>			
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7.0
LIGHTING POLES

The Street Light system and peripheral lighting shall be designed generally in line with design guidelines. Height of the poles should be chosen so as not to affect working of Solar panels. The poles shall be hot-dip galvanized as per relevant 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.

The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB.
Hot dipped Galvanised with 80 mm thickness hexagonal/Octagonal lighting pole with inbuilt JB shall also be acceptable

8.0
EARTHING

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 along with each conduit run. Cable armours shall be connected to earthing system at both the ends.

Alternately Vendor may offer technically superior and proven product subject to approval of employer.

9.0
AVERAGE ILLUMINATION LEVEL

Location	Average Illumination Level(Lux)	Type of Fixture
Control Room	300	LED Luminaries
Store Room	200	LED Luminaries
Switchgear Room, HT Breaker Room	150	LED Luminaries
Inverter Room	150	LED Luminaries
Street lighting-Roads	10	LED Luminaries
Switchyard and Substation	20(general) 50(on strategic equipment)	LED Luminaries
Security Room Lighting	50	LED Luminaries

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C-12) AUXILLARY POWER SUPPLY SYSTEM

Auxiliary power supply arrangement shall be in line with tender SLD drawing no. 5716-004-POE-A-006 Rev B.

Each inverter room shall have its own auxiliary power supply system comprising of AC distribution board (ACDB) which shall be fed from inverter output through suitably rated transformers. All ACDB's shall receive at least two incomers from different sources. All Auxiliary loads like illumination, SMU, Washing etc. shall be fed from this ACDB. However auxiliary power supply for Power Conditioning Unit and other emergency loads (SCADA, control and protection requirement of switchgears and emergency lighting etc. shall be taken through suitably rated UPS fed from this ACDB. Size and rating of UPS shall be chosen as per criteria specified elsewhere in the specification. In case the PCU does not require any external Auxiliary power supply bidder may choose to supply suitable DC system in place of the above UPS for feeding of control and protection loads of switchgear, SCADA, Emergency lighting and other emergency loads.

Bidder shall refer to drawing no. 5716-004-POE-A-006/ 2 Rev B in case more than two inverters are proposed in each room. If the bidder propose to install only two inverter in each inverter room drawing No. 5716-004-POE-A-006/1 Rev B shall be referred.

For measurement of Auxiliary power consumption, MFM in ACDB incomer shall be provided by the bidder

C-13) BATTERY AND BATTERY CHARGER AT MAIN POOLING SWITCHGEAR/CMCS ROOM

GENERAL

For Sizing of Battery, Bidder has to submit the calculation considering the following loads (included but not limited to) with standby time of two (02) hours.

1. Trip and closing Coils of all HT Breakers
2. Semaphore / LED indications of the Panels for Mimics and indications
3. DC supply for Protection Relay (Numeric / Electromechanical)
4. Spring Charging Motors of HT Breakers (to be decided during detailed engineering).

BATTERY RATINGS

1. For Ni-Cd Type Battery		
a)	Battery Voltage	To be decide during Detail Engineering
b)	No. of Cells	To be decide during Detail Engineering
c)	Battery type	Nickel-Cadmium
d)	Nominal discharge voltage per Cell	1.2
e)	Float voltage	1.42V/Cell
2. For Lead Acid Plante type Battery		
a)	Battery Voltage	To be decide during Detail Engineering

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b)	No. of Cells	To be decide during Detail Engineering
c)	Battery type	Stationary Lead Acid Plante
d)	Nominal discharge voltage per cell	2.0V
e)	Float Voltage	2.25V/Cell

PART-A: NICKEL-CADMIUM BATTERY

1.0

CODES AND STANDARDS

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 techno-commercial bid.

In case of conflict between this specification and those (IS codes, Standards etc.) referred to herein, the former shall prevail. All works shall be carried out as per the following standards and codes:

IEC 60623 / IS 10918	Specification for vented type Nickel Cadmium Batteries.
IS 106	Quality tolerances for water for storage batteries
IEC 60993	Electrolyte for vented Nickel-Cadmium cells
Indian electricity rules	
Indian Electricity Acts.	

2.0

Equipment complying with other internationally accepted standards such as IEC., BS, VDE 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 techno-commercial bid and shall clearly bring out the salient features for comparison.

3.0

GENERAL TECHNICAL REQUIREMENT

Equipments

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	<p>(a.) DC Batteries shall be stationary Nickel Cadmium Pocket plate type conforming to IS:10918. The batteries shall be high discharge performance type as specified. For the purpose of design an ambient temperature of 50 degree centigrade and relative humidity of 85% shall be considered.</p> <p>(b.) DC batteries shall be suitable for standby duty. The batteries shall normally be permanently connected to the load in parallel with a charger and shall supply the load during emergency conditions when AC supplies are lost. Batteries shall be suitable for a long life under continuous float operations and occasional discharges. The batteries shall be boost charged at about 1.54 to 1.7 volts per cell maximum and float charged at about 1.42 V/cell.</p> <p>(c.) The number of cells for the 220 Volts shall be 169, number of cells for 110V shall be 85.</p> <p>(d.) Batteries should be suitable for continuous operation for the maximum ambient temperature as defined in technical parameters.</p> <p>Construction Features</p> <p>Containers</p> <p>Containers shall be made of polypropylene plastic material. Containers shall be robust, heat resistance, leak proof, non absorbent, alkali resistant, non-bulging type and free from flaws, such as wrinkles, cracks, blisters, pin holes etc. Electrolyte level lines shall be marked on container in case of translucent containers.</p> <p>Vent Plugs</p> <p>Vent plugs shall be provided in each cells. They shall be antisplash type, having more than one exit hole shall allow the gases to escape freely but shall prevent alkali from coming out. The design shall be such that the water loss due to evaporation is kept to minimum. In addition the ventilator shall be easily removed for topping up the cells and of such dimensions that the syringe type hydrometer can be inserted into the vent to take electrolyte samples.</p> <p>Plates</p> <p>The plates shall be designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load. The construction of plates shall conform to latest revisions of IS:10918.</p>			
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	<p>The separators shall maintain the electrical insulation between the plates and shall allow the electrolyte to flow freely. Separators should be suitable for continuous immersion in the electrolyte without distortion.</p> <p>The positive and negative terminal posts shall be clearly marked.</p> <p>Sediment Space</p> <p>Sufficient sediment space shall be provided so that cells will not have to be cleaned during normal life and prevent shorts within the cells.</p> <p>Electrolyte</p> <p>The electrolyte shall be prepared from battery grade potassium hydroxide conforming to IEC 60993.</p> <p>The cells can be shipped either in charged condition or in dry condition</p> <p>Necessary electrolyte for make-up shall be supplied separately.</p> <p>Connectors and Fasteners</p> <p>Nickel plated copper connectors shall be used for connecting adjacent cells and PVC insulated flexible copper cables shall be used for inter-row / inter-tier / inter-bank connections. Bolts, nuts and washers shall be Stainless Steel / Nickel coated steel to prevent corrosion. The thickness of Nickel coating of connectors should be not less than 0.02 mm. All the terminals and cells inter-connectors shall be fully insulated or have insulation shrouds. End take off connections from positive and negative poles of batteries shall be made by single core cables having stranded AL conductors and XLPE insulation. Necessary supports and lugs for termination of these cables on batteries shall also be supplied by the contractor. All connectors and lugs shall be capable of continuously carrying the 30 minutes discharge current of the respective batteries and through fault short circuit current which the battery can produce and withstand for the period declared. Contractor shall furnish necessary sizing calculations to prove compliance to the same. Suitable number of Inter-rack connectors shall be supplied by the Bidder to suit the battery room layout during detailed engineering.</p> <p>Battery racks</p> <p>Mild steel racks for all the batteries shall be provided. They shall be free standing type mounted on porcelain/hard rubber/PVC pads insulators/High impact plastic insulators. Batteries shall preferably be located in the single tier arrangement. However, batteries having a complete cell weight of lower than 50 Kg could be located in the double tier arrangement. The batteries racks and supports for cable termination shall be coated with three (3)</p>			
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6.0	<p>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> <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> <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> <p>GENERAL</p> <p>The Contractor shall submit for Owner’s approval the reports of all the type tests carried out as per latest IS-1146(for all applicable tests for containers) / IS-10918 (for NI-CD batteries). The complete type test reports shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier.</p> <p>Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of battery.</p> <p>Commissioning Checks:</p> <p>All tests as listed below shall be carried out on sample cell selected at random by the employer at site after completion of installation.</p> <ul style="list-style-type: none"> • Physical Examination • Dimensions, Mass & layout • MARKING • Polarity and absence of short circuit. • Ampere - hour capacity • Retention of charge • Insulation resistance <p>The Contractor shall arrange for all necessary equipment, including the variable resistor, tools, tackles and instruments.</p>			
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7.0	PART-B: LEAD –ACID PLANTE BATTERY			
	CODES & STANDARDS			
8.0	IEC 60896 Stationary Lead-Acid Batteries			
	IS : 266 Specification for sulphuric acid			
	IS : 1069 Specification for water for storage batteries			
	IS : 1146 Specification for rubber & plastic containers for lead acid storage batteries.			
	IS : 1652 Specification for stationary cells and batteries, lead acid type (with plante positive plates).			
	IS : 3116 Specification for sealing compound for lead acid batteries.			
	IS : 8320 General requirements and methods of tests for lead acid storage batteries.			
	IS : 6071 Specification for synthetic separators for lead acid batteries.			
	Indian Electricity Rules			
	Indian Electricity Acts			
Equipment complying with other internationally accepted standards such as IEC, BS, VDE 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 techno-commercial bid and shall clearly bring out the salient features for comparison.				
GENERAL TECHNICAL REQUIREMENTS				
EQUIPMENTS				
DC Batteries shall be stationary lead acid Plante positive plate type conforming to IS:1652. The battery shall be high discharge performance type. For the purpose of design an ambient temperature of 50 degree centigrade and relative humidity of 85% shall be considered.				
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	<p>DC Batteries shall be suitable for standby duty. The Batteries shall normally be permanently connected to the load in parallel with a charger and shall supply the load during emergency conditions when AC supplies are lost. Batteries shall be suitable for a long life under continuous float operations and occasional discharges. The batteries shall be boost charged at about 2.7 volts per cell maximum and float charged at about 2.25 V/cell:</p> <p>The number of cells for the 220 Volts shall be 107, number of cells for 110V shall be 54.</p> <p>Batteries should be suitable for continuous operation for the maximum ambient temperature as defined in technical parameters.</p> <p>Construction Features</p> <p>Containers</p> <p>Containers shall be made of transparent glass, hard rubber, suitable robust, heat resistance, leak proof, non absorbent, acid resistant, non-bulging type and free from flaws, such as wrinkles, cracks, blisters, pin holes etc. Electrolyte level lines shall be marked on container in case of transparent containers. Float type level indicator shall be provided in case of opaque containers. The stem portion of the float should be long enough to prevent falling of the float inside the container even if there is no electrolyte in the container. The marking for the electrolyte level should be for the upper and lower limits. The material of level indicator shall be acid proof and oxidation proof. Container shall be closed/sealed lid type. Lid and sealing compound shall be non-cracking type. The container made of hard rubber and plastics shall be type tested as per IS : 1146. All type tests shall be carried out for sealing compound as per IS:3116.</p> <p>The pole sealing arrangement should be such that no acid particle get entrapped due to acid creep as a result of capillary action and it should be possible to remove and refix the sealing to carry out the maintenance.</p> <p>Vent Plugs</p> <p>Vent plugs shall be provided in each cells. They shall be antisplash type, having more than one exit hole shall allow the gases to escape freely but shall prevent acid from coming out. The design shall be such that the water loss due to evaporation is kept to minimum. In addition the ventilator shall be easily removed for topping up the cells and of such dimensions that the syringe type hydrometer can be inserted into the vent to take electrolyte sample.</p> <p>Plates</p> <p>The plates shall be designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load.</p>			
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	<p>The construction of plates shall conform to latest revisions of IS : 1652 as applicable.</p> <p>The separators shall maintain the electrical insulation between the plates and shall allow the electrolyte to flow freely. Separators should be suitable for continuous immersion in the electrolyte without distortion. The positive and negative post shall be clearly marked.</p> <p>Sediment Space</p> <p>Sufficient sediment space shall be provided so that cells will not have to be cleaned during normal life and prevent shorts within the cells.</p> <p>Cell Insulator</p> <p>Each cell shall be separately supported on PVC/porcelain/hard rubber insulators fixed on the racks with adequate clearance between adjacent cells. Minimum distance between adjacent cells shall be more than the bulge allowed for two cells in accordance with IS:1146.</p> <p>Electrolyte</p> <p>The electrolyte shall be prepared from battery grade sulphuric acid conforming to IS:266 and distilled water conforming to IS:1069. The cells shall be shipped dry uncharged. The electrolyte shall be supplied separately.</p> <p>Connectors and Fasteners</p> <p>Lead or Lead coated copper connectors shall be used for connecting up adjacent cells and rows. Bolts, nuts and washers shall be effectively lead coated to prevent corrosion. The thickness of lead-coating of connectors should not be less than 0.025 mm. The lead coating thickness shall be measured in accordance with APPENDIX F of IS:6848 (latest edition). All the terminals and cells inter-connectors shall be fully insulated or have insulation shrouds. End take off connections from positive and negative poles of batteries shall be made by single core cables having stranded copper conductors and PVC insulation. Necessary supports and lugs for termination of these cables on batteries shall also be supplied by the contractor. All connectors and lugs shall be capable of continuously carrying the 30 minutes discharge current of the respective Batteries and through fault short circuit current which the battery can produce and withstand for the period declared. Contractor shall furnish necessary sizing calculations to prove compliance to the same.</p> <p>Battery racks</p> <p>Wooden racks for all the batteries shall be provided. These racks shall be made of good quality first class seasoned teak wood in line with CPWD specification. They shall be free standing type mounted on porcelain/hard rubber/PVC pads insulators/High impact plastic insulators. Batteries shall</p>			
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9.0	<p>preferably be located in the single tier arrangement. However, batteries having a complete cell weight of lower than 50 Kg could be located in the double tier arrangement. The batteries rack and wooden support for cable termination shall be coated with three (3) coats of anti-acid paint of approved shade. Numbering tags, resistant to acid, for each cell shall be attached on to the necessary racks. The bottom tier of the stand shall not be less than 150 mm above the floor. Wherever racks are transported in dismantled condition, suitable match markings shall be provided to facilitate easy assembly.</p> <p>Manufacturer's Identification Systems</p> <p>The following information shall be indelibly marked on outside of each cell.</p> <ol style="list-style-type: none"> Manufacturer's name and trade marks Country and year of manufacture. Manufacturer type designation. AH capacity at 10 hour discharge rate. Serial number Verification of Markings 			
	<p>TESTS</p> <p>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 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.</p> <p>However if the 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.</p>			
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10.0	<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> <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> <p>GENERAL</p> <p>The Contractor shall submit for Owner’s approval the reports of all the type tests carried out as per latest IS-1146(for all applicable tests for containers) / IS-1652 (for Lead-acid Plante batteries). The complete type test reports shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier.</p> <p>Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of battery.</p> <p>Commissioning Checks:</p> <p>All tests as listed below shall be carried out on sample cell selected at random by the employer at site after completion of installation</p> <ol style="list-style-type: none"> 1) Verification of markings. 2) Verification of dimensions. 3) Test for capacities for 10 hrs discharge rate alongwith the test for voltage during discharge. <p>The Contractor shall arrange for all necessary equipment, including the variable resistor, tools, tackles and instruments.</p> <p>BATTERY CHARGER</p>		
11.0	<p>CODES AND STANDARDS</p> <p>All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and</p>		
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revisions as on date of opening of techno-commercial 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 and codes.

ANSI-C 37.90a	Guide for surge withstand capability tests
IS:5	Colours for ready mix paints.
IS : 694	PVC Insulated Cable for working voltages upto and including 1100 V.
IS : 1248	Specification for Direct acting indicating analogue electrical measuring instruments.
IS:13947 Part-1	Degree of protection provided by enclosures for low voltage switch gear and control gear.
IS : 13947	Specification for low voltage switch gear and control gear
IS : 3231	Electrical relays for power system protection.
IS : 3842	Application guide for Electrical relays for AC System
IS : 3895	Mono-crystalline semi-conductor Rectifier Cells and Stacks
IS : 4540	Mono crystalline semi-conductor Rectifier assemblies and equipment.
IS:6005	Code of practice for phosphating of Iron and Steel.
IS:6619	Safety Code for Semi-conductor Rectifier Equipment.
IS:6875	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto 1000 V AC or 1200 VDC.
IS : 9000	Basic environmental testing procedures for electronic and

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	electrical items.
IS:13703	Low voltage fuses for voltages not exceeding 1000 V AC or 1500 VDC.
EEUA-45D	Performance requirements for electrical Alarm Annunciation System
	Indian Electricity Rules
	Indian Electricity Act.

Equipment complying with other internationally accepted standards such as IEC, BS, VDE 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 along with copies of all official amendments and revisions in force as on date of opening of techno-commercial bid and shall clearly bring out the salient features for compare

12.0

EQUIPMENT DESCRIPTION

PART-I BATTERY CHARGER FOR LEAD ACID PLANTE TYPE BATTERY

1. The Battery Chargers as well as their automatic regulators shall be of static type. Battery chargers shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated DC lead-acid Batteries while supplying the D.C. loads. The Batteries shall be Trickle charged at 2.25 Volts per cell. All chargers shall also be capable of Boost Charging the associated D.C. Battery at 2.3 to 2.7 Volts per cell at the desired rate. The Chargers shall be designed to operate, as mentioned above, at an ambient air temperature of 50°C.
2. All Battery Chargers shall have provision to receive two input supplies along with suitable automatic changeover between the sources.
3. Battery Chargers shall have a selector switch for selecting the battery charging mode i.e. whether Trickle or Boost charging.

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	<p>4. All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. Means shall be provided to avoid current/voltage surges of harmful magnitude/nature which may arise during changeover from Auto to Manual mode or vice-versa under normal operating condition.</p> <p>5. Soft start feature shall be provided to build up the voltage to the set value slowly within fifteen seconds. The chargers shall have load limiters which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the load limiter setting of the Charger. The load limiter characteristic shall be such that any sustained overload or short circuit in DC system shall neither damage the Charger nor shall it cause blowing of any of the charger fuses. The Charger shall not trip on overload or external short circuit. After clearance of fault, the Charger voltage shall build up automatically when working in automatic mode.</p> <p>6. When on automatic control mode during Trickle charging, the Charger output voltage shall remain within $\pm 1\%$ of the set value for AC input voltage variation of $\pm 10\%$, frequency variation of $\pm 3-5\%$, a combined voltage and frequency (absolute sum) variation of 10% and a continuous DC load variation from zero to full load. Uniform and step-less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire Trickle charging output range specified & shall be capable of matching the float voltage correction recommendations(w.r.t. temperature) as suggested by the respective battery manufacturer. Step-less adjustment of the load limiter setting shall also be possible from 80% to 100% of the rated output current for Trickle charging mode.</p> <p>7. During Boost charging, the Battery Chargers shall operate on constant current mode (When automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode. The charger output voltage shall automatically go on rising, when it is operating on boost mode, as the battery charges up. For limiting the output voltage of the charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of</p>			
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	<p>this voltage anywhere in the output range specified for boost charging mode. All voltage and current setting potentiometers shall be vernier type.</p> <p>8. Energizing the Charger with fully charged battery connected plus 10% load shall not result in output voltage greater than 110% of the voltage setting. Time taken to stabilize, to within the specified limits as mentioned elsewhere, shall be less than fifteen seconds.</p> <p>9. Momentary output voltage of the Charger, without the Battery connected shall be within 94% to 106% of the voltage setting during sudden load Change from 100% to 20% of full load or vice-versa. Output voltage shall return to, and remain, within the limits specified as mentioned elsewhere in less than 2 seconds after the above mentioned change.</p> <p>10. The Charger manufacturer may offer an arrangement in which the voltage setting device for Trickle charging mode is also used as output voltage limit setting device for Boost charging mode, and the load limiter of the trickle charging mode is also used as Boost charging current setting device.</p> <p>11. Suitable filter circuits shall be provided in all the Chargers to limit the ripple content (peak to peak) in the output voltage to 1% irrespective of the DC load, even when they are not connected to a battery.</p> <p>12. The DC System shall be ungrounded and float with respect to the ground potential when healthy. An earth fault relay shall be provided by the bidder in the DC distribution board for remote annunciation.</p> <p>13. Digital Outputs shall be configured for connection to the Solar SCADA for real-time charger status updation. Outputs like charger output current, output voltage, float/boost mode, etc may be configured to provide the update to SCADA.</p> <p>PART-II BATTERY CHARGER FOR NICKEL-CADMIUM TYPE BATTERY</p> <p>1. The Battery Chargers as well as their automatic regulators shall be of static type. Battery chargers shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated DC Nickel-Cadmium Batteries while supplying the D.C.</p>			
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	<p>loads. The Batteries shall be Trickle charged at 1.4 to 1.42 Volts per cell. All chargers shall be capable of Boost Charging the associated D.C. Battery at 1.53 to 1.7 Volts per cell at the desired rate. The Chargers shall be designed to operate, as mentioned above, at an ambient air temperature of 50°C.</p> <ol style="list-style-type: none"> 2. All Battery Chargers shall have provision to receive two input supplies along with suitable automatic changeover between the sources. 3. Battery Chargers shall have a selector switch for selecting the battery charging mode i.e. whether Trickle or Boost charging. 4. All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. Means shall be provided to avoid current/voltage surges of harmful magnitude/nature which may arise during changeover from Auto to Manual mode or vice-versa under normal operating condition. 5. Soft start features shall be provided to build up the voltage to the set value slowly within fifteen seconds. The chargers shall have load limiters which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the load limiter setting of the Charger. The load limiter characteristic shall be such that any sustained overload or short circuit in DC system shall not damage the Charger, nor shall it cause blowing of any of the charger fuses. The Charger shall not trip on overload or external short circuit. After clearance of fault, the Charger voltage shall build up automatically when working in automatic mode. 6. When on automatic control mode during Trickle charging, the Charger output voltage shall remain within +/-1% of the set value for AC input voltage variation of +/-10%, frequency variation of +3 to -5%, a combined voltage and frequency (absolute sum) variation of 10% and a continuous DC load variation from zero to full load. Uniform and stepless adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire Trickle charging output range specified & shall be capable of matching the float voltage correction recommendations(w.r.t. 			
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	<p>temperature) as suggested by the respective battery manufacturer. Stepless adjustment of the load limiter setting shall also be possible from 80% to 100% of the rated output current for Trickle charging mode.</p> <ol style="list-style-type: none"> 7. During Boost charging, the Battery Chargers shall operate on constant current mode (When automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode. The charger output voltage shall automatically go on rising, when it is operating on boost mode, as the battery charges up. For limiting the output voltage of the charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage anywhere in the output range specified for boost charging mode. All voltage and current setting potentiometers shall be vernier type. 8. Energising the Charger with fully charged battery connected plus 10% load shall not result in output voltage greater than 110% of the voltage setting. Time taken to stabilise, to within the specified limits as mentioned elsewhere shall be less than fifteen seconds. 9. Momentary output voltage of the Charger, without the Battery connected shall be within 94% to 106% of the voltage setting during sudden load Change from 100% to 20% of full load or vice-versa. Output voltage shall return to, and remain, within the limits specified as mentioned elsewhere in less than 2 seconds after the above mentioned change. 10. The Charger manufacturer may offer an arrangement in which the voltage setting device for Trickle charging mode is also used as output voltage limit setting device for Boost charging mode, and the load limiter of the trickle charging mode is also used as Boost charging current setting device. 11. Suitable filter circuits shall be provided in all the Chargers to limit the ripple content (peak to peak) in the output voltage to 1% irrespective of the DC load, even when they are not connected to a battery. 12. The DC System shall be ungrounded and float with respect to the ground potential when healthy. An earth fault relay shall be provided by the bidder in the DC distribution board for remote annunciation. 			
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	<p>13. Digital Outputs shall be configured for connection to the solar SCADA for real-time charger status updation. Outputs like charger output current, output voltage, float/boost mode, etc may be configured to provide update to SCADA.</p> <p>Printed Circuits Boards (PCB)</p> <p>PCB shall be made of glass epoxy of 1.6 mm thick, fire resistant, bonded with 99.8% pure copper foil, free of wrinkles, blisters, scratches and pinholes. The contact surface of the edge connectors of the PCBs shall be plated with hard gold to a minimum thickness of 5 microns. Component identification shall be printed on PCB by silk screen method. All PCBs shall be tropicalised and masked.</p> <p>Contactors</p> <p>All Battery Chargers shall have an AC contactor on the input side. It shall be of air break type and suitable for continuous duty. The operating coil shall be rated for 415 Volts AC.</p> <p>Thermal Overload Relay</p> <p>A thermal overload relay incorporating a distinct single phasing protection (using differential movement of bimetal strips) shall also be provided for the AC input. The relay shall trip the above contactor.</p> <p>Rectifier-Transformers and Chokes</p> <p>The rectifier transformer and chokes shall be dry and air cooled (AN) type. The rating of the rectifier-transformers and chokes shall correspond to the rating of the associated rectifier assembly. The rectifier-transformers and chokes shall have class-B insulation with temperature rise limited to class-A insulation value.</p> <p>Rectifier Assembly</p> <p>The rectifier assembly shall be full wave bridge type and designed to meet the duty as required by the respective Charger. The rectifier cells shall be provided with their own heat dissipation arrangement with natural air cooling. The rectifier shall utilise diodes/thyristors and heat sinks rated to carry 200% of the load current continuously and the temperature of the heat sink shall not be permitted to exceed 85°C absolute duly considering the maximum charger panel inside temperature. The Contractor shall submit calculations to show what maximum junction temperature will be and what the heat sink temperature will be when operating at 200% and 100% load current continuously duly considering the maximum surrounding air temperature for these devices inside the charger panel assuming air ambient temperature of 50°C outside the panel. Necessary surge</p>			
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protection devices and rectifier type fast acting fuses shall be provided in each arm of the rectifier connections.

Digital Indicating Instruments

Digital indicating instruments with built in communication port for remote data transfer shall be provided for all chargers. The instruments shall indicate DC current, DC voltage & AC voltage and instrument shall be 96 x 96 mm², with display accuracy 0.5%, 4 digit-7 segment LED/LCD display and RS 485 Serial Bus port.

Air Break Switches

All Chargers shall have AC input and DC output switches of air break, single throw, load break and fault make type. The contacts of the switches shall open and close with a snap action. Switches shall be rated for 120% of the maximum continuous load. 'ON' & 'OFF' position of the switch shall be clearly indicated.

Control And Selector Switches

Control and selector switches shall be of rotary stayput type with escutcheon plates showing the functions and positions. The switches shall be of sturdy construction and suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred. The contact ratings shall be atleast the following:

- (a.) Make and carry continuously – 10 Amps.
- (b.) Breaking current at 220 V DC – 0.5 Amp. (inductive)
- (c.) Breaking current at 240 V AC – 5 Amp. At 0.3 p.f.

Fuses

Fuses shall be of HRC cartridge fuse link type. Fuses shall be mounted on fuse carriers which are mounted on fuse bases. Wherever it is not possible to mount fuses on fuse carriers, fuses shall be directly mounted on plug in type bases. In such cases one insulated fuse pulling handle shall be supplied for each charger. Kick-off fuses (trip fuses) with alarm contacts shall be provided for all D.C. fuses.


Indicating Lamps


Three (3) indicating lamps shall be provided to indicate A.C. supply availability. The indicating lamp shall be of panel mounting, filament type low wattage or LEDs and capable of clear status indication under the normal room illumination. The lamps shall be provided with series resistors (non-hygroscopic) preferably built in the lamp assembly and replaceable from front. The lamp covers shall be preferably screwed type, unbreakable and moulded from heat resistant material


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13.0	<p>Blocking Diode</p> <p>Blocking diode shall be provided in the output circuit of each Charger to prevent current flow from the D.C. Battery into the Charger.</p> <p>Annunciation System</p> <p>Visual indications through indicating lamps/LEDs or annunciation facia as per EEUA-45D shall be provided in all Chargers for the following:</p> <ul style="list-style-type: none"> (a.) A.C. supply failure (b.) Rectifier fuse failure (c.) Surge circuit fuse failure (d.) Filter fuse failure (e.) Load limiter operated (f.) Charger trip (g.) Battery on Boost <p>Potential free NO contacts of all above conditions shall be provided for following remote alarms in the SCADA</p> <ul style="list-style-type: none"> (a) Battery on Boost (b) Charger trouble (this being a group alarm initiated by any of the faults other than 'Battery on Boost') <p>Name Plates and Marking</p> <p>The name plates shall be made of non-rusting metal/3 ply Lamicoid and shall have black back-ground with white engraved letters and secured by screws. These shall be provided near top edge on the front as well as on rear side of Charger. Name plates with full and clear inscriptions shall also be provided on and inside the panels for identification of the various equipments.</p>			
	<p>CONSTRUCTION</p> <p>The Chargers shall be indoor, floor mounted, self supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Charger shall be fabricated using cold rolled sheet steel shall not less than 1.6 mm and shall have folded type of construction. The panel frame shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm. Removable undrilled gland plates of at least 3.0 mm sheet steel and lugs for all cables shall be</p>			
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	<p>supplied by the Contractor. The lugs for cables shall be made of electrolytic copper with tin coat. Cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and gland plates. The Charger shall be tropicalised and vermin proof. Ventilation louvers shall be backed with fine brass wire mesh. All doors and covers shall be fitted with synthetic rubber gaskets. The Chargers shall have hinged double leaf doors provided on front and/or backside for adequate access to the Charger internals. All the Charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be atleast IP-42.</p> <p>All indicating instruments, control & selector switches and indicating lamps shall be mounted on the front side of the Charger. Design of panels shall be based on the following dimensions.</p> <ol style="list-style-type: none"> 1) Overall height - Maximum 2350 mm 2) Operating handles - Maximum 1800 mm (highest and lowest positions reached by operator's hands), protective mechanical indicators Minimum 350 mm 3) Doors and panel handles and locks - Maximum 1800 mm Minimum 300 mm <p>Electronic equipments shall be of modular design consisting of plug in modules in standard 19 inches metallic racks with metallic card guides. The cards should be provided with proper handles. Card to card wiring should be preferably through a mother board. Unplanned jumpering and track modifications are not permitted. Mechanical interlocks to prevent wrong insertion of cards should be provided. Each card shall have its junction and test points identified. Maintenance aids such as extension printed wiring boards and jumper leads shall be provided.</p> <p>The layout of Charger components shall be such that their heat losses do not give rise to excessive temperature within the Charger panel surface. Location of the electronic modules will be such that temperature rise of the</p>			
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	<p>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 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.</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 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.</p> <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> <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> <p>GENERAL</p> <ol style="list-style-type: none"> 1. The contractor shall furnish the following type tests reports for each rating of the equipment to be supplied under this contract. <ol style="list-style-type: none"> a) Complete physical examination b) Temperature rise test at full load. For chargers of up to 400A rating, Temperature rise test report for rectifier assembly at 200% of full load shall also be submitted.) c) Insulation resistance test. d) High voltage (power frequency) test on power and control
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	circuits except low voltage electronic circuits.			
	e) Ripple content test at			
	i) No load			
	ii) Half load			
	iii) Full load			
	f) Automatic voltage regulator operation test at specified A.C. supply variations at			
	i) No load			
	ii) Half load			
	iii) Full load			
	g) Load limiter operation test			
h) Efficiency and power factor measurement.				
i) Input and output surge withstand capability test. Surge Voltage as per ANSI-C37.90a shall be applied for period not less than 2 sec. At the following points of the Charger operating at full load :				
i) Across each A.C. input phase				
ii) Across AC input line to ground.				
iii) Across D.C. output terminals.				
iv) Across each D.C. output terminal to ground				
The Charger shall not exhibit any component damage and there shall be no change in performance as per (g) and (h).				
j) Environmental Tests				
Steady state performance tests (f) and (g) shall be carried out before and after each of the following tests.				
i) Soak Test				
The electronic modules shall be subjected to continuous operation for a minimum period of 72 hours.				
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17.0	<p>During last 48 hours, the ambient temperature shall be maintained at 50 deg. C. The 48 hour test period shall be divided into four equal 12 hour segments. The input voltage during each 12 hours shall be nominal voltage for 11 hours followed by 110% of nominal voltage for 30 minutes, followed by 90% of nominal voltage for 30 minutes.</p> <p>ii) Degree of protection test.</p> <p>2. Dynamic response test and Temperature rise test at full load shall be carried out on each charger before dispatch at manufacturer's works.</p>			
	<p>COMMISSIONING</p> <p>The contractor shall carryout the following commissioning tests and checks after installation of the equipment at site:</p> <ul style="list-style-type: none">a) Complete physical examination.b) Checking of proper operation of annunciation system.c) Insulation resistance test.d) Automatic voltage regulator operation.e) Load limiter operation.f) Updation of charger status in DC Battery Health monitoring system			
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	<p>The UPS shall have an overload capacity of 125 % rated capacity for 10 minutes and 150 % rated capacity for 10 seconds. The inverter shall have sufficient capability to clear fault in the maximum rated branch circuit, limited to 8 percent of finally selected ups capacity. 2.01.00 Chargers</p>			
	<p>The chargers shall be self regulating, solid state silicon controlled, full-wave rectifier type designed for single and parallel operation with battery and shall have automatic voltage regulators for close voltage stability even when AC supply voltage fluctuates, effective current limiting features and filters to minimise harmonics. The charger should be capable to fully charge the required batteries as well as supply the full rated load through inverter. Furthermore the charger should be able to re-charge the fully discharged battery within 8 hours. The charger output regulation shall be $\pm 1\%$ from no load to full load with an input power supply variation of $\pm 10\%$ in voltage and $\pm 5\%$ in frequency. In addition to indications/display on charger panel, alarms along with relevant analog measurements shall also be provided by employing RS 485 Port Modbus Protocol / Ethernet TCP/IP protocol for use in DDCMIS. The list of alarm output & 4-20 mA signals shall be as approved by Employer during detailed engineering.</p>			
	<p>The charger shall be current limited for charger circuit protection and protection of battery from overcharge shall also be provided. The current limit shall be continuously adjustable. The chargers shall have a slow walk-in circuit which shall prevent application of full load DC current in less than 10 seconds after AC power is energised.</p>			
	<p>The chargers shall be fed from 415V AC, 50 HZ, 3 phase, 3 wire system. Charger design shall ensure that there is no component failure due to fluctuations of input supply or loss of supply and restoration.</p>			
	<p>The minimum full load efficiency at nominal input and output shall be 90%. The ripple content shall be limited to $\pm 2\%$ of Charger output voltage.</p>			
	<p>The UPS battery shall have sufficient amp-hour capacity to supply the steady state KVA rating of the UPS specified for 120 minute, irrespective of the actual load on UPS.</p>			
	<p>The UPS system shall be capable of operating without D.C. battery in circuit under all conditions of load and the performance of various components of UPS like inverter, charger, static switch etc. shall be guaranteed without the battery in circuit.</p>			
<p>The UPS system design shall ensure that in case of failure of mains input power supply to one of the chargers, the other charger whose mains input power supply is healthy, shall feed to one or both the inverters as the case may be as per manufacturer's standard practice & continue to charge the D.C. battery at all load conditions. The Bidder should note that this situation</p>				
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should not in any way lead to the discharge of the D.C. Battery.

Static Inverters

The static inverter shall be of continuous duty, solid state type using proven Pulse Width Modulation (PWM)/Quasi square wave/step wave technique. Ferro-resonant types Inverters are not acceptable. The nominal voltage output shall be 230 Volts. single phase ,50 Hz. The inverter equipment shall include all necessary circuitry and devices to conform to requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. The steady state voltage regulation shall be $\pm 2\%$ and transient voltage regulation (on application/removal of 100% load) shall be $\pm 20\%$. Time to recover from transient to normal voltage shall not be more than 50 mSec. Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination shall be better than $\pm 0.5\%$ (automatically controlled). The total harmonic content shall be 5% maximum and content of any single harmonic shall be 3% maximum. The inverter efficiency shall be at least 85% on full load and 80% on 50% load. The synchronisation limit for maintenance of synchronisation between the inverter and stand by AC source shall be 48-52Hz, field adjustable in steps of 1 Hz.

Static Switch and Manual Bypass Switch


The static switch shall be provided to perform the function of transferring UPS loads automatically without any break from (i) faulty inverter to healthy inverter in case of failure of one of the two inverters and (ii) from faulty inverter to standby AC source in case of failure of both the inverters. The transfer time shall be $\frac{1}{4}$ cycle maximum in synchronous mode.


Manual bypass switch shall be employed for isolating the UPS during maintenance.

Continuous and overload capacity of the switches shall be equal to 100% of the continuous and overload rating of each inverter. Peak Capacity shall be 1000% of continuous rating for 5 cycles.

Isolation Transformer and Voltage Stabiliser:

Isolation transformer of appropriate voltage and phase as per system requirement along with associated voltage stablizer shall be furnished with each UPS system.

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3.0	<p>The transformer shall be of low impedance air-cooled type and its KVA rating and percentage impedance should be selected so that extremely fast fault clearance is achieved.</p> <p>The overload capacity of the transformer and voltage stabilizer shall not be less than 300% for 200 millisecond duration. The voltage stabilizer shall employ servo-controlled circuitry and shall maintain the specified output voltage for 0-100% load with maximum input voltage variations as indicated above. The efficiency of the stabiliser shall be 95% or better.</p> <p>The type and other details shall be subject to Employer’s approval.</p>							
	<p>BATTERIES</p> <p>Contractor has the option of supplying either Nickel Cadmium type batteries or Lead Acid Plante type batteries. The detailed specification for the batteries has been mentioned elsewhere in this specification.</p> <p>For sizing calculation, an aging factor of 0.8 and a temperature correction factor as per manufacturer’s standard at 4 deg.C electrolyte temperature (Based on temperature characteristics curve to be submitted by the Contractor at a temperature of 4 deg. C), Capacity factor, float correction (if applicable) shall be taken into consideration. The sizing of the battery shall be as approved by Employer during detailed engineering. The Contractor shall typically consider a voltage drop of 4V from battery room to the inverter input while sizing the battery for UPS System.</p>							
4.0	<p>AUXILIARY EQUIPMENTS</p> <p>All required auxiliary equipment/materials as finalized during detailed engineering shall be furnished with each rectifier bank, UPS & battery bank and shall include as a minimum various meters (AC/DC voltage/current, kVA, power factor, frequency meters etc), circuit breakers, selector switches, push buttons indicating lights, ground detector system, battery accessories like (inter cell connectors, inter step connectors, battery racks etc.) isolated 4-20 mA signals for important parameters and potential free contacts for important alarms shall be provided for use in SCADA.</p> <p>Manual Discharge Resistance bank of adequate capacity for UPS Power Supply System.</p> <table><tr><td>Hydrometer</td><td>2 Nos.</td></tr><tr><td>b Set of hydrometer syringes suitable for the vent holes in different cells</td><td>2 Nos.</td></tr></table>				Hydrometer	2 Nos.	b Set of hydrometer syringes suitable for the vent holes in different cells	2 Nos.
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	c	Thermometer for measuring electrolyte temperature	2 Nos.	
	d	Specific gravity correction chart	2 Nos.	
	e	Wall mounting type holder made of teak wood for hydrometer & thermometer	2 Nos.	
	f	Cell testing voltmeter (3-0-3 V)	3 Nos.	
	g	Alkali mixing jar	2 Nos.	
	h	Rubber aprons	5 Nos.	
	i	Pair of rubber gloves	5 Nos.	
	j	Set of spanners	5 Nos.	
	k	No smoking notice for each battery room	2 Nos.	
	l	Goggles (industrial)	2 Nos.	
	m	Instruction card	5 Nos.	
	n	Temperature indicator	1 No. per room	
	o	Cell lifting facility	1 Set per room	
	5.0	DRAWINGS/DOCUMENTS REQUIREMENTS		
		Bidder shall furnish the power supply distribution scheme, single line diagram, all calculations such as Rectifier Modules / UPS Charger / Inverter rating calculations, battery sizing calculation etc. for UPS during detailed engineering for Employer's review and approval.		
6.0	CABINETS / ENCLOSURES / POWER DISTRIBUTION BOXES			
	The Construction details for Power Supply System Cabinets/ Enclosure/Racks shall conform to the requirements of the following paragraphs.			
	(1) Equipment enclosures shall match and line up in assemblies of freestanding floor mounted cabinets designed for indoor service.			
	(2) Individual enclosure shall be ventilated switchboard type fabricated from not less than 1.6-mm thick sheet steel. Enclosures shall be furnished with concealed hinges. Front and rear doors shall be designed to permit easy access to all components for maintenance			
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<p>7.0</p> <p>8.0</p>	<p>or replacement. The enclosures shall be reinforced with formed steel members as required to form a rigid self-supporting structure. Doors shall have three point latches.</p> <p>(3) Each assembly may be shipped in sections for ease of handling and field assembly. Terminal blocks shall be furnished as required adjacent to each shipping split to facilitate field assembly. Cable bundles cut to the required length and furnished with terminal lugs tagged for identification shall be provided for the wiring between shipping sections.</p> <p>(4) Adequate ventilating louvers and enclosure top panels shall be included. All vent openings shall be covered with corrosion resistant fine screen coverings.</p> <p>(5) The temperature rise inside all the cabinets/enclosures shall not exceed 10 deg.C above ambient temperature. The cabinets shall be IP-42 protection class .</p> <p>(6) The Colour shade of Panels exterior/interior shall be as per RAL 9002, end panel Colour shall be as per RAL 5012.</p> <p>COOLING SYSTEM</p> <p>If the equipment supplied requires forced air cooling, the cooling system furnished shall meet the following requirements:</p> <p>(1) Reserve cooling equipment shall be furnished for each assembly. Reserve fan(s) capacity shall be equal to 100 percent of cooling fan requirements for full load operation with only one bank of rectifier/inverter in service at the specified maximum ambient temperature.</p> <p>(2) Completely independent duplicable wiring and control systems shall be provided for the normal cooling fan system and the reserve cooling fan system.</p> <p>(3) Each cooling fan shall normally run continuously and shall be powered from the output of the inverter whose enclosure it serves (for cubicles housing inverters). For other cubicles, fan power supply shall be as finalised during detailed engineering. Each cooling fan supply circuit shall be separately fused.</p> <p>(4) Each cooling fan shall be equipped with a switch having an alarm contact that closes upon failure of airflow or rise of temperature.</p> <p>SITE TESTS</p> <p>The Contractor shall also carry out the site tests on equipments/systems as</p>		
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9.0	<p>specified below. However, these shall not be limited to this specification only and in case any other site test is required to be conducted as a standard practice of the Contractor or deemed necessary by the Employer and mutually agreed between the Contractor and the Employer, the same shall also be carried out.</p> <p>FUNCTIONAL TEST</p> <p>On completion of installation and commissioning of the equipment the following tests/checks shall be carried out with the max. available load, which does not exceed the rated continuous load. These tests/checks shall include but not limited to the tests as indicated below.</p> <p>The details of the tests are as indicated below:</p> <ol style="list-style-type: none"> 1. Light Load Test <p>This test is carried out to verify that the UPS is correctly connected and all functions operate properly. The load applied is limited to some percent of rated value. The following points should be checked:</p> <ol style="list-style-type: none"> (a) Output voltage, frequency and the correct operation of meters; (b) Operation of all control switches and other means to put units into operation. (c) Functioning of protective and warning devices. (d) Operation of remote signaling and remote control devices. 2. Checking of Auxiliary Devices <p>The functioning of auxiliary devices, such as lighting, cooling, pumps, fans, annunciation, etc., should be checked, if convenient, in conjunction with the preliminary light load test.</p> 3. Synchronisation Test <p>If possible, frequency variation limits should be tested by use of a variable frequency generator, otherwise, by simulation of control circuit conditions. If applicable the rate of change of frequency during synchronization shall be measured.</p> 4. A. C. Input Failure Test <p>The test is performed with a fully charged battery and is carried out by tripping input circuit breakers or may be simulated by switching off all UPS rectifiers and bypass feeder as at the same time. Output</p> 		
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	<p>voltage variations are to be checked for specified limits with an oscilloscope or equivalent. Frequency variation is defined as the steady state frequency of the UPS with and without AC input. The rate of change of frequency is measured by the time it takes to reach steady-state values.</p> <p>5. A. C Input Return Test</p> <p>AC input return test is performed by closing AC input circuit breakers, or is simulated by energizing rectifiers and bypass feeders.</p> <p>Proper operation of rectifier starting and voltage and frequency variations are to be observed.</p> <p>Note: This test is normally performed with a fully of partially charged battery.</p> <p>6. Simulation of Parallel Redundant UPS Fault</p> <p>This test is applicable for UPS with parallel redundant connections. Faults of rectifier or inverter units may be carried out by simulation. Output transients are to be observed.</p> <p>7. Transfer Test</p> <p>This test is applicable for UPS with bypass, particularly in the case of an electronic bypass switch. Transients shall be measured during load transfer to bypass caused by a simulated fault and load retransfer after clearing of the fault.</p> <p>8. Full load test</p> <p>Load tests are performed by connecting the actual load to the UPS output.</p> <p>Large UPS in parallel connection may be load tested by testing the individual UPS units separately. Load tests are necessary for testing output voltage and frequency, rated stored energy, recharge time, ventilation, temperature rise and determination of efficiency. Load tests are performed to prove transient voltage deviations specified under step load conditions.</p> <p>9. Efficiency</p> <p>Efficiency should be determined by the measurement of the active power at input and output.</p> <p>10. Actual Load Test</p> <p>Conditions under actual load may differ from those with a dummy load. Steady-state generation of current and voltage harmonics and transients at load switching conditions should be observed</p>			
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	<p>11. Current Division in Parallel</p> <p>Load sharing between the Modular DC power supply rectifier banks & UPS units shall be measured with actual load under conditions of parallel operation.</p> <p>12. Rated Stored Energy Time (Battery Test)</p> <p>This test is a load test to prove the actual possible time of battery operation.</p> <p>If rated load is not available in the case of large UPS, it is possible to apply a partial load to check the actual battery discharge characteristics and compare these with characteristics specified by the battery manufacturer. Discharge time with rated load shall then be calculated. The test shall be performed with a fully charged battery and also may be done under other battery conditions to be specified, if so agreed. Active power output of the UPS and the battery voltage shall be recorded during the test.</p> <p>Since new batteries often do not provide full capacity during a starting up period, the discharge test may be repeated after a reasonable recharge time if the original test has failed.</p> <p>13. Rated Restored Energy Time</p> <p>Restored energy depends on the charging capacity of the rectifiers and the battery characteristics. If a certain recharging rate is specified, it shall be provided by repeating the discharge test after the specified charging period.</p> <p>14. Battery Ripple Current</p> <p>If battery ripple currents are specified, then the ripple current which depends on UPS operation shall be checked under normal operating conditions. Rough measuring methods are sufficient.</p> <p>15. On site Ventilation Test</p> <p>The test is performed with the actual load. Temperature conditions of all Modular DC power supply rectifiers & UPS cubicles are to be observed.</p> <p>16. Overload Capability Test</p> <p>Overload capability test is a load test. Specified values of short time overload or starting up sequences of actual load are to be applied for the time interval specified. Specified values of voltage and current are to be recorded.</p> <p>17. Short Circuit Current Capability</p> <p>If short-circuit current capability is specified, it may be tested by</p>			
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10.0	<p>applicable of a short circuit to UPS output if necessary, via a suitable fuse, Short-circuit current is to be recorded.</p> <p>18. Short Circuit Fuse Test</p> <p>Fuse tripping capability of a UPS shall be tested, by short-circuiting the UPS output via a fuse of specified type.</p> <p>The test shall be repeated to ensure against fuse non-uniformity and switching time during the cycle. The test is carried out at an appropriate UPS load, under normal operation, if not otherwise specified by Employer.</p> <p>19. Restart</p> <p>Automatic or other restart means are to be tested after a completed shut-down as specified.</p> <p>20. Output Over voltage</p> <p>Output over voltage protection is to be checked.</p> <p>21. Periodic output voltage modulation</p> <p>When this test is specified, it may be checked by voltage recording at different loads and operating conditions.</p> <p>22. Harmonic Components</p> <p>Harmonic components of output voltage shall be checked with the actual load. Methods of specification and checking shall be subject to Employer's approval.</p> <p>23. Earth Fault Test</p> <p>If the DC Power Supply/ UPS output is isolated from earth, then an earth fault can be applied to any output terminal. DC Power Supply/ UPS output transients (if any) shall be measured.</p> <p>If the battery is isolated from earth, then an earth fault can be applied to any output terminals. DC Power Supply/ UPS output transient (if any) shall be measured.</p> <p>UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM (FOR LESS THAN 05 KVA RATING)</p> <p>On line UPS with remote monitoring having a battery backup of two (02) hours. The batteries for UPS System shall be Tubular type.</p> <p>The minimum capacity of the UPS at load factor of 0.8 lagging inclusive of 10% design margin at 50 deg C.</p>
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	<p>The UPS system shall meet the following requirements as a minimum.</p> <p>If UPS KVA rating is applicable at a lower ambient temperature than specified 50 deg.c, the bidder shall consider a derating factor of at least 1.5%/deg.c for arriving at the specified UPS capacity at 50 deg.c ambient. The UPS shall have an overload capacity of 125 % rated capacity for 10 minutes and 150 % rated capacity for 10 seconds. The inverter shall have sufficient capability to clear fault in the maximum rated branch circuit, limited to 8 percent of finally selected ups capacity.</p> <p>During the sizing of the UPS, the following loads shall be considered (but not limited to) ----</p> <ul style="list-style-type: none"> • Data logger / SCADA • Fire Detection/ Alarm Panel • HMI of SCADA • Emergency Lighting • Inverter's Auxiliary supply (if applicable) <p>The sizing of the battery shall be as approved by Employer during detailed engineering.</p>		
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	<p style="text-align: center;">C-15) TIME SYNCHRONISATION EQUIPMENT</p> <p>1.0 Time Synchronization equipments shall be provided and shall be located in the Control Room. It shall receive Coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite (GPS) for time synchronization of all components of the SCADA.</p> <p>2.0 It shall be complete in all respects including antenna, all cables, processing equipment, etc.</p> <p>3.0 All auxiliary systems and special cables required for synchronization of the equipment shall be supplied and commissioned by the Contractor.</p> <p>4.0 It shall work from DC supplies only and the Contractor to clarify if any built-in battery backup is provided, in which case, same shall be of long life lithium batteries.</p> <p>5.0 It shall be immune to hostile electrical environment. Suitable protections are to be provided against lightning surges and over-voltages in power supply systems and antenna feeders.</p> <p>6.0 The system shall be fully tested to the relevant international standards such as IEC: 801 and IEC: 255.</p> <p>7.0 All components of the SWYD SAS, including Substation Controllers, Workstations, Bay Control Units (BCU) and Bay Protection units (BPU) and all numeric protection relays shall be synchronized with an accuracy of 1ms.</p> <p>8.0 The GPS shall be synchronized with the SCADA system to be supplied under this contract and all devices which are communicating with Solar SCADA shall be synchronized with GPS. Necessary software and Hardware (including laying of communication cable) required for time synchronization with SCADA and all other devices shall be in scope of contractor.</p> <p>9.0 The system should be able to track more than 1 satellite at a time to ensure no interruptions of synchronization signals.</p> <p>10.0 The system shall have provisions for combination of any of the following output signals:</p> <ul style="list-style-type: none"> • NTP (network time protocol) 100Mbits Ethernet port • IRIG-B00x (TTL, pulse width modulated signal) • 2 x Pulse per half-hour/ Pulse per minute/ Pulse per second outputs via potential free contacts • Any other output port as may be required for the offered system. 			
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<p>11.0</p> <p>12.0</p>	<ul style="list-style-type: none"> Alarm status contact indicating healthy status of system <p>These output ports shall be compatible with the requirement of the equipment to be synchronized i.e. BCUs and BPUs. The master clock in control room shall also be synchronized with the time synchronization system. The actual port requirements (no./type) in line with the system offered shall be finalized during detailed engineering.</p> <p>The equipment should have a periodic time correction facility of one-sec. periodicity. The equipment shall also have real time display in hour, minute, second (24 hour mode) and have a separate time display, having display size of approx. 144mm height.</p>
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	C-16) 33kV OVERHEAD LINE EQUIPMENTS			
	Following specification of this section for Overhead line equipments is applicable wherever contractor proposes to carry power from one location to other location through overhead line and is approved by employer during detail engineering. Application of individual equipments mentioned in this section shall be subject to system requirement.			
	1.0	CONDUCTOR		
	This specification covers design, manufacture, testing before dispatch, supply and delivery of All Aluminium (AA), Aluminum Conductors Steel Reinforced (ACSR) All Aluminum Alloy (AAA) Conductors.			
2.0	APPLICABLE STANDARD			
The Conductor shall strictly comply with the following Indian Standard Specification relevant to the conductor.				
<div>i. IS : 398- Aluminium Coductors for Over head Transmission Purposes (Part-I):Aluminium Stranded Conductors</div> <div>ii. IS :398- Aluminium Coductors for Over head Transmission Purposes (Part-II): Aluminium Conductors Galvanised steel reinforced</div> <div>iii. IS :398- Aluminium Coductors for Over head Transmission Purposes(Part- Specification for Aluminium Alloy (Aluminium, Magnesium ,Silicon Type)</div>				
3.0	MATERIAL			
The conductors shall be of best quality and workmanship. The steel reinforced aluminum conductors shall be manufactured of hard drawn EC grade aluminum wires and high tensile galvanized steel wires of the sizes and with mechanical and electrical properties as specified in the Standard. The coating on the galvanized steel wires may be applied by the hot process or electrolytic process in accordance with IS: 4826-1968 (specifications for galvanized coating on round steel wires).AAA Conductor shall however be constructed of heat-treated aluminum magnesium silicon alloy wire. The wires shall be smooth and free from all imperfections such as spills and splits and rolling and wire drawing defects etc. resulting in reduction in cross-sectional area over the entire length				
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I.
POLES
DESIGN PARAMETERS

Maximum span of HT Lines with proposed conductors shall be as per REC construction standards or as specified in the table below.

The following types of pole configurations shall be used at respective locations given below after finalization of survey & pole spotting

a.	SP (Single Pole support)	i) 0° - 10° deviation.
b.	DP (Double Pole support)	ii) 10° - 60° deviation.
c.	FP (Four Pole support)	(iii) 60° - 90° deviation

Design Parameters

- a) Factor of safety 2.0 in normal condition for 33 kV
- b) Wind Pressure on Pole & conductor– As per IS 802
- c) Wind load on cross-arms, insulators guy-wire etc. shall be considered.
- d) Wind load on full projected area of conductors and pole is to be considered for design.
- e) Ground clearance shall be minimum 5.2m for 33 kV line f) Ground clearance shall be minimum 4m for 11 kV ABC line & LT ABC line.
- f) All other clearance shall be as per IE Rules.
- g) The live metal clearance shall be as per IS: 5613 and shall be min.330 mm for 33 kV line.

Pole accessories like danger plates, phase plates, anti climbing device, shall be provided.

1. Excavation of pole pit

Excavation cost for pits shall be included by the contractor in the bid for following type of soils inclusive of dewatering of pits and shoring and shuttering wherever necessary.

a) All type of soils and soil conditions but excluding hard rock

For the purpose of pole planting, normally pit size shall be 600x500x1500 (mm). In case bidder employs Earth augers, the Pit size can be considered 0.7 meter dia with 1.5 meter depth.

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	<p>b) Hard rock</p> <p>For hard rock locations, 1 meter deep hole of diameter 20% in excess of the longest dimension of the bottom most portion of pole shall be excavated. The pole shall be grouted in the pit with 1:2:4 nominal concrete mix at the time of pole erection. For hard rock, the excavation cost per location shall remain same for all type of foundations. Controlled blasting shall be permitted only in case of hard or rocky soil.</p> <p>The contractor shall be responsible for any damage or accidents arising out of the process of blasting. Blasting shall not be permitted if the area around location is inhabited. In such case, the contractor shall have to follow other methods like drilling etc.</p> <p>2. PCC footing and compaction of soil</p> <p>The planting depth of pole shall be 1500 mm in the ground except in wet soil and black cotton soil where depth shall be increased by 0.2 mtr. to 0.3 mtr. with reduced wind span.</p> <p>3. Earthing of Poles</p> <p>In 33 kV, each pole shall be earthed with spike type earthing as per REC Construction Standard J-2. All DP & Four pole structures & the poles on both sides of railway, Telecommunication, road, drain & river crossing shall be earthed by pipe earthing as per enclosed REC Construction Standard J-2.</p> <p>In rocky areas where digging of earth pits up to 1500mm is not possible spike earthing in horizontal configuration buried at a depth of not less than 800mm may be used</p> <p>In rocky areas where individual earthing of poles is not possible, an overhead GI earth wire shall be run as per REC construction standard drawing- A5. This earth wire shall be earthed at three different points in one Km using pipe earthing as per REC construction standard J2. The dimension of over head GI earth wire shall not be less than 6mm dia. & 4mm dia respectively for 33KV & 11KV lines</p> <p>4. Providing Of Guys/Strut Poles To Supports</p> <p>The arrangement for guys shall be as per REC Construction. Strut poles/flying guys wherever required shall be installed on various pole locations as per REC construction standards .For selection of guying</p>			
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	<p>locations REC guidelines & construction practices & IS :5613 shall be followed. The stay rod should be placed in a position so that the angle of rod with the vertical face of the pit is 30⁰/45⁰ as the case may be.</p> <p>In this work anchor type guy sets are to be used. These guys shall be provided at</p> <ul style="list-style-type: none"> (i) Angle locations (ii) Dead end locations (iii) T-off points (iv) Steep gradient locations. (v) Double Pole, & four poles (vi) Wind stays along tangent locations at 40% of pole locations (vii) For double pole structure (DP), four stays along the line, two in each direction and two stays along the bisection of the angle of deviation (or more) as required depending on the angle of deviation are to be provided. Hot dip galvanized stay sets are to be used. <p>G.I. stay wires of size 7/3.15 mm (10 SWG) with GI turn buckle rod of 16 mm dia & 16 mm dia GI stay rods, shall be used for 11KV & LT line.</p> <p>G.I. stay wires of size 7/4 mm with GI turn buckle rod of 20 mm dia & 20 mm dia GI stay rods shall be used for 33 KV line.</p> <p>Precast RCC anchor plate as per REC construction standard K1 shall be used for the purpose of anchoring the guy rod with a bolt arrangement at one end and other end is given shape of 40mm dia circle to bind one end of the stay wire.</p> <p>The size of the stay pit shall be 500mmx500mmx1600mm with concrete mix of 1:2:4 having volume in stay pit of 800x500x500=0.2 cubic mtr for embedding RCC stay plate assembly and the balance pit to be filled with earth duly rammed.</p> <p>In case of firm soil, concreting is not required.</p> <p>The turn buckle shall be mounted at the pole end of the stay and guy wire so fixed that the turn buckle is half way in the working position, thus giving the maximum movement for tightening or loosening.</p> <p>If the guy wire proves to be hazardous, it should be protected with suitable asbestos pipe filled with concrete of about 2 m length above the ground level, painted with white and black strips so that, it may be visible at night.</p> <p>5. Cross Arms</p>		
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II.	<p>Cross Arms for 33 kV Overhead Power Lines shall be made out of 100x50x6 mm M.S. channel.</p> <p>For 33 KV line, cross arms a MS strip of 100x50x5 mm shall be welded for providing additional mechanical strength at the seat of the pin insulator</p> <p>Fixing of Cross Arms</p> <p>After the erection of supports and providing guys, the cross-arms are to be mounted on the support with necessary clamps, bolts and nuts. The practice of fixing the cross arms before the pole erection can also be followed. In case, the cross-arm shall be mounted after the pole is erected, the lineman should climb the pole with necessary tools. The cross-arm shall then tied to a hand line and pulled up by the ground man through a pulley, till the cross-arm reaches the line man. The ground man should station himself on one side, so that if any material drops from the top of the pole, it may not strike him. All the materials should be lifted or lowered through the hand line, and should not be dropped.</p>			
	<p>CLAMPS AND CONNECTORS</p> <p>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 the terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetallic.</p> <p>The material of clamps and connectors shall be Galvanised mild steel for connecting to shield wire.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.</p>			
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III.	<p>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.</p>			
	<p>CIRCUIT BREAKERS</p> <p>Circuit Breakers shall be outdoor type, comprising three identical single pole units, complete in all respects with all fittings and wiring. The circuit breakers and accessories shall conform to IEC- 62271-100 or equivalent Indian Standard.</p>			
	<p>DUTY REQUIREMENTS</p> <p>Circuit breaker shall be totally 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 33 kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily.</p> <p>The circuit breaker shall be capable for breaking the steady & transient magnetizing current corresponding to 33 kV transformers. It shall also be capable of breaking line charging currents as per IEC- 62271-100 with a voltage factor of 1.4.</p> <p>The rated transient recovery voltage for terminal fault and short line faults shall be as per IEC: 62271-100.</p> <p>The circuit breaker shall be reasonably quiet in operation. Noise level in excess of 140 dB measured at base of the breaker would be unacceptable. Bidder shall indicate the noise level of breaker at distance of 50 to 150 m from base of the breaker.</p> <p>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 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.</p> <p>While furnishing particulars regarding the D.C. component of the circuit breaker, the Bidder shall note that IEC-62271-100 requires that this value should correspond to the guaranteed minimum opening time under any condition of operation.</p>			
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The critical current which gives the longest arc duration at lock out pressure of extinguishing medium and the duration shall be indicated.

All the duty requirements specified above shall be provided with the support of adequate test reports to be furnished along with the bid.

OPERATING MECHANISM

Circuit Breaker shall be operated by electrically spring charged mechanism only.

The operating mechanism shall be anti-pumping and trip free (as per IEC definition) electrically and either mechanically or pneumatically under every method of closing. The mechanism of the breaker shall be such that the position of the breaker is maintained even after the leakage of operating media and/or gas. The circuit breaker shall be able to perform the duty cycle without any interruption.

Electrical tripping shall be performed by shunt trip coil. Provision shall also be made for local electrical control. 'Local / remote' selector switch and close & trip push buttons shall be provided in the breaker central control cabinet. Remote located push buttons and indicating lamps shall also be provided.

Operating mechanism and all accessories shall be in local control cabinet. A central control cabinet for the three poles of the breaker shall be provided along with supply of necessary tubing, cables, etc.

GENERAL PARAMETER

Type of circuit breaker	Vacuum/SF6 type
Highest system Voltage	36 Kv
Rated frequency	50 Hz
Number of poles	Three (3)
Rated/minimum power frequency Withstand voltage	70 Kv
Rated lightning impulse Withstand voltage	170 Kv
Minimum Creepage distance	25 mm/Kv of highest system voltage
Rated operating duty cycle	O - 0.3 sec. - CO - 3min. – CO

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Rated line charging breaking Current (voltage factor of 1.4)	As per IEC
Reclosing	Three phase high speed auto reclosing
Maximum fault level	25 kA (rms) for 1 sec.
Total closing time	Not more than 150 ms.
Auxiliary contacts	As required plus 4NO and 4NC contacts per pole as spare.
Noise level	Maximum 140dB at 50m distance from base of circuit breaker
Seismic acceleration	0.3 g horizontal

IV. ISOLATORS

The isolators and accessories shall conform in general to IEC 62271-102 (or equivalent Indian standard) except to the extent explicitly modified in specification.

Earth switches shall be provided on isolators wherever called for.

Operating mechanism of Isolator and earth switch	Manual Operated
Nominal system voltage	33kV
Highest system voltage	36kV
Type	Outdoor
Rated short time current of isolator and earth switch	25 kA (rms) for 1 sec.
Rated dynamic short time withstand current of isolator and earth switch	62.5kA (peak)
Impulse withstand voltage with 1.2/50 micro sec. wave	170kVp to earth 195 kVp across isolating distance
One minute power frequency withstand Voltage	70 kV (rms) to earth & 80 kV (rms) across isolating distance
Temperature rise	As per Table-IV of IS: 9921
Rated mechanical terminal load	As per 62271-102
Creepage distance (Total)	900 mm
Line charging breaking capacity	6.3 A
Transformer off-load breaking capacity	6.3 A

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V.	<p>Isolator shall be gang operated for main blades and earth switches. The operation of the three poles shall be well synchronised and interlocked.</p> <p>The design of linkages and gears shall be such so as to allow one man to operate the handle with ease for isolator and earth switch.</p> <p>They shall be constructed such that they do not open under influence of short circuit current and wind pressure 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.</p> <p>In addition to the constructional interlock, isolator and earthswitches 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 circuit of the motor to prevent opening or closing of isolators when the interlocking coil is not energised.</p> <p>INSTRUMENT TRANSFORMER</p> <p>a) GENERAL REQUIREMENT</p> <p>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. The tank as well as top metalics shall be hot dip galvanised or painted Grey color as per RAL 9002.</p> <p>The instrument transformers shall be oil filled hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs.</p> <p>Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.</p> <p>The insulators shall have cantilever strength of more than 500 kg.</p> <p>b) MARSHALLING BOX</p> <p>The wiring diagram for the interconnection of three phase instrument transformer shall be pasted inside the box in such a manner so that it is</p>
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	<p>visible and it does not deteriorate with time. 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.</p> <p>c) CURRENT TRANSFORMERS (CTs) The CTs shall have single primary of either ring type or hair pin type or bar type. In case of "Bar Primary" inverted type CTs, the following requirements shall be met:</p> <p>The secondaries shall be totally encased in metallic shielding providing a uniform equi-potential surface for even electric field distribution.</p> <p>The lowest part of insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.</p> <p>The upper part of insulation assembly sealing on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly and top dome.</p> <p>The CT shall be provided with oil sight glass.</p> <p>Different ratios shall be achieved by secondary taps only, and primary reconnections shall not be accepted.</p> <p>The guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.</p> <p>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.</p> <p>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.</p> <p>The CTs shall be suitable for horizontal transportation.</p> <p>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,</p>			
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i.e. frequency of test, norms of acceptance, quantity of oil to be withdrawn, and treatment of CT.

The CT shall have provision for measurement of capacitance and tan delta as erected at site.

d) PARAMETERS FOR CURRENT TRANSFORMERS

GENERAL PARAMETERS

Highest system Voltage(Um)	36 kV
Rated frequency	50 Hz
System neutral earthing	effective earthed
Installation	Outdoor
Rated short time thermal current	25 kA for 1 sec
Rated dynamic current	63 kA (Peak)
Rated min power frequency withstand voltage (rms value)	70kV
Rated lightning impulse withstand voltage (peak value)	170kV
Partial discharge level	10 pico Coulombs max.
Minimum Creepage distance	25 mm/kV of highest system voltage
Temperature rise	As per IEC 60044
Type of insulation	Class A
Number of cores	Tariff CTs shall be single metering core with 0.2S accuracy class.
Number of terminals in marshalling box	All terminals of control circuits wired upto marshalling box plus 20 terminals spare

e) VOLTAGE TRANSFORMERS (VTs)

Voltage transformers shall be electro-magnetic (EMU) type and 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.

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 IP55. The access to secondary terminals shall be without the danger of access to high voltage circuit.

The accuracy of metering core shall be maintained through the entire burden range upto 50VA on all three windings without any adjustments during operations.

f) PARAMETERS FOR VOLTAGE TRANSFORMERS

GENERAL PARAMETERS

Highest System Voltage(Um)	36 kV
System neutral earthing	effective earthed
Installation	Outdoor
System Fault level	25 kA
Rated min power frequency withstand voltage (rms value)	70kV
Rated lightning impulse withstand voltage (peak value)	170kV
Standard reference range of frequencies for which the accuracy are valid	96% to 102% for protection and 99% to 101% for measurement
Rated voltage factor	1.2 continuous & 1.5 for 30 sec
Class of Accuracy	For tariff metering VT - 0.2 Other VTs – 0.2
Stray capacitance and stray conductance of LV terminal over entire carrier frequency range	As per IEC:358
One Minute Power frequency Withstand voltage for secondary winding	2 kV rms
Temp. rise over an ambient temp. of 50 deg. C	As per IEC 60044
Number of terminals in control spare.	All terminals of control circuits wired Cabinet upto marshalling box plus 10 terminals
Rated total thermal burden	350 VA
Partial discharge level	10 pico Coulombs max.

VI.

SURGE ARRESTOR

The surge arrestors (SAs) shall conform in general to IEC 60099-4 or IS: 3070 except to the extent modified in the specification. Arresters shall be of

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hermetically sealed units, self-supporting construction, suitable for mounting on lattice type support structures. Bidder shall furnish the technical particulars of Surge arrester.

The SAs shall be of heavy duty station class and gapless Metal Oxide type without any series or shunt gaps. The SAs shall be capable of discharging over-voltages occurring during switching of unloaded transformers, and long lines.

Arrestors shall be complete with insulating base for mounting on structure. Self-contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit with necessary connection. Suitable leakage current meters should also be supplied within the same enclosure. The reading of millimeter and counters shall be visible through an inspection glass panel

The surge arrestors shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with IEC-60099-4

Rate System Voltage	36 kV
Rate Arrester Voltage	30 kV
Nominal discharge current	10 kA of 8/20 micro-sec wave
Minimum discharge capability	5 kilo joule/kV(referred to rated arrester voltage corresponding to minimum discharge characteristics)
Maximum continuous operating	24 kV rms
Max. residual voltage (1 kA)	70 kVp
Max. residual voltage at 10 kA nominal discharge current (8/20 micro sec wave)	85 kVp
Max. switching impulse residual Voltage at 500A peak	70 kVp
Max. steep current residual voltage	93 kVp at 10kA
High current short duration test Value (4/10 micro-sec-wave)	100 kAp
Current for pressure relief test	25kA rms
One minute power frequency withstand voltage of arrester housing (dry and wet)	70 kV (rms)
Impulse withstand voltage of arrester housing with 1.2/50 micro sec. Wave	170 kV (Peak)

VII.

INSULATORS

Porcelain insulator shall comply IS: 731-1976 or equivalent international standard and 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. Hollow porcelain should be in one integral piece in green & fired stage

Pin insulators shall be used on all poles in straight line and disc or shackle insulators on angle and dead end poles.

Strain insulators shall be used at line sectionalizing locations, dead end locations, major crossings and locations where the angle of deviation of line is more than 10° .

For 33KV lines Ball & Socket type strain insulators with fittings shall be used.

The pins for insulators shall be fixed in the holes provided in the cross-arms and the pole top brackets. The insulators shall be mounted in their places over the pins and tightened. In the case of strain or angle supports, where strain fittings are provided for this purpose, one strap of the strain fittings is placed over the cross-arm before placing the bolt in the hole of cross-arms. The nut of the straps shall be so tightened that the strap can move freely in horizontal direction

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.

In one span, Tension string assembly at one end shall be supplied with suitable turn buckle.

DISC INSULATOR

The disc insulator shall meet the following parameters:

- Type : Antifog type insulator
- Size of insulator : 255x145
- Electro mechanical strength : 120kN
- Leakage distance (mm) : 430mm minimum or as required to

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	<p>meet the total creepage.</p> <p>e. Power frequency withstand voltage : 85 kV (dry), 50kV (wet)</p> <p>Bushings shall be manufactured and tested in accordance with IS:2099 & IEC:137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5284. The support insulators shall be manufactured and tested as per IS:2544 / IEC 168/IEC 273. The insulators shall also conform to IEC 815 as applicable.</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> <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. Hollow porcelain should be in one integral piece in green & fired stage.</p> <p>Glazing of the porcelain shall be uniform brown in colour, free from blisters, burns and other similar defects.</p> <p>When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or when operating at normal rated voltage.</p> <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> <p>Contractor shall make available data on all the essential features of design including the method of assembly of shells and metal parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.</p> <p>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.</p>			
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	<p>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 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> <p>All acceptance and routine tests as per relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.</p>		
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1.	<p style="text-align: center;">C-17) ENERGY METERING SYSTEM</p> <p>ENERGY METERING SYSTEM</p> <p>Three No. Energy meters (Main, Check and Standby) of 0.2s accuracy class suitable for ABT requirement conforming to respective RLDC/State power Utilities/CTU.requirement shall be provided at both export feeders. These energy meters shall be provided in a separate outdoor metering cubicle with padlock arrangement.</p> <p>In addition to above One Energy meter of 0.2s accuracy class suitable for ABT requirement shall be provided at each export feeder. This energy meter shall be provided in the outgoing feeder panel of 33kV main pooling switchgear.</p> <p>For measurement of Auxiliary power consumption, MFM in ACDB incomer shall be provided by the bidder.</p> <p>a) Meter shall be suitable for interfacing for synchronizing the built in clock of the meter by GPS time synchronization equipment. Bidder shall synchronize the meter using GPS time synchronization equipment. All the hardwire required for synchronization shall be in the scope of the bidder All Type test reports as per IEC 62052-11/62053-22</p> <p>The ABT meters supplied under this contract shall also meet the requirement of respective RLDC/State power Utilities/CTU.</p> <p>Technical Requirements of Energy Meters for ABT Requirement</p> <p>a. Shall be microprocessor-based conforming to IEC 60687/IEC 62052-11/IEC 62053-22/IEC 62056/IS 15959 for category B.</p> <p>b. Shall carry out measurement of active energy (both import and export) and reactive energy (both import and export) by 3-phase, 4 wire principle suitable for balanced/ unbalanced 3 phase load.</p> <p>c. Shall have an accuracy of energy measurement of at least Class 0.2S for active energy and at least Class 0.5 for reactive energy.</p> <p>d. The active and reactive energy shall be directly computed in CT & VT primary ratings.</p>			
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- e. The reactive energy shall be recorded for each metering interval in four different registers as MVARh (lag) when active export, MVARh (Lag) when active import, MVARh (lead) when active export, MVARh (Lead) when active import.
- f. Two separate registers shall be provided to record MVARH when system voltage is $>103\%$ and when system voltage is $< 97\%$.
- g. Shall compute the net MWh and MVARh during each successive 15-minute block metering interval along with a plus/minus sign, instantaneous net MWh, instantaneous net MVARh, average frequency of each 15 minutes, net active energy at midnight, , net reactive energy for voltage low and high conditions at each midnight.
- h. Each energy meter shall have a display unit with a seven digit display unit. It shall display the net MWh and MVARh with a plus/minus sign and average frequency during the previous metering interval; peak MW demand since the last demand reset; accumulated total (instantaneous) MWh and MVARh with a plus/minus sign, date and time; and instantaneous current and voltage on each phases.
- i. All the registers shall be stored in a non-volatile memory. Meter registers for each metering interval, as well as accumulated totals, shall be downloadable. All the net active/reactive energy values displayed or stored shall be with a plus /minus sign for export/import.
- j. At least the following data shall be stored before being over-written for the following parameters:-

	Parameters	Details	Min No. of days
1	Net MWH	15 min block	40 days in meter
2	Aver Freq	15 min block	40 days in meter
3	Net MVARH for $V>103\%$	15 min block	40 days in meter
4	Net MVARH for $V<97\%$	15 min block	40 days in meter
5	Cumulative Net MWH at 15 min block every midnight		10 days in meter/ 40days in PC
6	Cumulative Net MVARH for $V>103\%$ at every midnight		10 days in meter/ 40days in PC

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	<p>7 Cumulative Net MVARH for 10 days in V<97% at every midnight meter/ 40days in PC</p> <p>Date and time blocks of VT failure on any phase This should also additionally comply with the stipulations of the SEB</p> <p>k. Shall have a built in clock and calendar with an accuracy of less than 15 seconds per month drift without assistance of external time synchronizing pulse.</p> <p>l. Date/time shall be displayed on demand. The clock shall be synchronized by GPS time synchronization equipment.</p> <p>m. The meter shall be suitable to operate with power drawn from the VT supplies. The burden of the meters shall be as per relevant standard.</p> <p>n. The power supply to the meter shall be healthy even with a single-phase VT supply. An automatic backup, in the event of non-availability of voltage in all the phases, shall be provided by a built in long life battery and shall not need replacement for at least 10 years with a continuous VT interruption of at least 2 years & by a auxiliary power supply of 220V DC. Even under absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meter. Date and time of VT interruption and restoration shall be automatically stored in a non-volatile memory.</p> <p>o. Shall have an optical port on the front of the meter for data collection from either a hand held meter reading instrument (MRI) having a display for energy readings or from a notebook computer with suitable software.</p> <p>p. The meter shall have means to test MWh and MVARh accuracy and calibration at site in-situ and test terminal blocks shall be provided for the same.</p> <p>q. Each meter shall have a unique identification code provided by the Owner and shall be permanently marked on the front of the meter and stored in the nonvolatile memory of the meter.</p> <p>r. Even under the absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meters.</p>			
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	<p>The owner shall have the right to carry out surprise inspections of the metering systems from time to time to check their accuracy</p> <p>In addition to above space for mounting another energy meter shall be provided in the C&R panel.</p>			
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<p>1.00.00</p> <p>1.01.00</p> <p>1.01.01</p> <p>1.01.02</p> <p>1.01.03</p> <p>1.01.04</p> <p>1.01.05</p> <p>1.01.06</p> <p>1.01.07</p> <p>1.01.08</p> <p>2.00.00</p> <p>2.01.00</p>	<p align="center">C-18) CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM</p> <p>CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM</p> <p>General Requirements</p> <p>The intent of the specification is to define the functional & design requirements for the CCTV System meant for gathering video information from the various areas of the power plant with display and recording facilities with night vision and motion sensors as per requirement.</p> <p>The Contractor shall be responsible for selection, design, engineering, manufacture, testing at manufacturer's works/site, installation of all the equipments supplied as covered in this specification and commissioning of the system meeting the intent & functional requirements of the specification. All the power supply (UPS), cables, cable trays, power packs, erection hardware (viz. junction boxes, brackets glands, nut-bolts, conduits etc.) and mounting are also included in Contractor's scope.</p> <p>The Contractor's scope shall also include successful demonstration of functional requirements specified herein complete in all respects.</p> <p>The Contractor shall guarantee satisfactory performance of the equipment under stipulated variations of voltage and frequency.</p> <p>The design and manufacture shall be such that equipment / components of same type and rating are interchangeable.</p> <p>The number of camera units, servers, network switches, wireless equipment etc. and their locations shall; be finalized during detailed engineer for effective functional requirements.</p> <p>Any other equipment, module, software required for the safe and satisfactory operation, control, protection, monitoring, testing and maintenance of the system shall also be included by the Bidder within the lump sum quoted price.</p> <p>The equipment furnished under this section shall meet the requirements of all the applicable International codes and standards or their latest amendment Codes and Standards. Camera certification has to be CE/FCC/UL or equivalent.</p> <p>POWER SUPPLY ARRANGEMENT</p> <p>The CCTV System along with all its system components i.e. network switches, storage devices, servers, LAN switches, media converters etc. shall be powered from UPS system. Contractor shall also provide local power distribution boxes as required for sub-distribution of UPS supply.</p>			
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2.02.00	For cameras, mini UPS of suitable rating are to be provided by the contractor. Contractor shall also provide local power distribution boxes as required for sub-distribution of supply from mini-UPS to cameras. The location of mini-UPS & power distribution scheme shall be finalized during detail engineering.
2.03.00	If the offered equipment is operating at voltage level other than what is available as auxiliary supply, the Contractor shall provide all required hardware, to make the offered system compatible with specified power supply arrangement.
3.00.00	DESIGN AND TECHNICAL REQUIREMENTS
3.01.00	<p>The CCTV system shall be able to provide surveillance of different locations in the plant, entry gate and all across periphery. The exact locations shall be decided during detailed engineering.</p> <p>The CCTV system shall be designed as a standalone IP based network architecture. System shall use video signals from different cameras at different locations, process the video signals for viewing on monitors at different locations and simultaneously record all the video streams using H.264 or better compression technique. Joystick and mouse-keyboard controllers shall be used for Pan, Tilt, Zoom and other functions of desired cameras.</p>
3.04.00	<p>The monitoring of these cameras shall be done at main Control Room or as finalized in detailed engineering. The required no. of hardware/software licenses to meet the requirements shall be supplied by the contractor.</p> <p>Camera and database servers shall offer both video stream management, video stream storage management. These servers shall also manage and store configuration information/database for the whole system. Recording frame rate & resolution in respect of individual camera shall be programmable. It shall be possible to view and record at different resolutions and frame rates and this shall be individually programmable on every camera.</p> <p>It shall be possible to take back-up of system configuration and database on portable media device and restoring the same if required.</p>
3.05.00	System shall ensure that once recorded, video can not be altered.
3.06.00	Camera server shall be provided with sufficient storage space to store recordings of all cameras at 25/30 FPS at 1920X1080 (For HD cameras) for a period of Fifteen (15) Days or more using necessary compression techniques. All recordings shall have camera ID, Location, Date and time of recording.
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<p>3.07.00</p> <p>3.08.00</p> <p>3.09.00</p>	<p>It shall be possible to view, record, search and replay simultaneously without affecting performance of the system.</p> <p>The system supplied shall be complete in all respects for reliable performance. The Contractor shall submit the detailed block schematic, video, signal & power wiring diagram, describing the connections between the network switch/camera server Systems and various cameras, monitors, keyboard, and joystick.</p> <p>The camera & Video Management Software shall conform to ONVIF profile S or latest available applicable ONVIF profile at the time of detail engineering.</p>
<p>4.00.00</p> <p>4.01.00</p> <p>4.01.01</p> <p>4.01.02</p> <p>4.01.03</p> <p>4.02.00</p> <p>4.02.01</p>	<p>DETAILED DESCRIPTION OF THE SYSTEM COMPONENTS:</p> <p>Application Software for Video Monitoring, Recording & Management.</p> <p>The application software shall be used to display, store, control & manage the entire surveillance system.</p> <p>It shall be possible to control all cameras i.e. PTZ, auto/manual focus, selection of presets, video tour selection etc. The software shall support flexible 1/2/4 windows split screen display mode or scroll mode on the display monitors for live video.</p> <p>The system shall support video analytics in respect of the following</p> <ol style="list-style-type: none"> 1. Video motion detection, 2. Object tracking 3. Object classification & Tracking <p>Night vision feature for complete darkness shall be available in all cameras</p> <p>The feature can be an integral part of camera or a part of camera server. The features shall be user configurable for each camera. It shall be possible to activate recordings automatically based on events generated by video analytics. These events shall also be logged and suitably alarmed on the monitors.</p> <p>Cameras:</p> <p>All the cameras shall be color, suitable for day and night surveillance (under complete darkness conditions) and network compatible. There will be two types of cameras viz. PTZ & Fixed. PTZ cameras shall be high speed integrated dome type.</p>
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4.02.02

Camera shall be directly connected to network and use of external encoder for connecting to network is not acceptable. The cameras shall be rugged, high performance color cameras. These cameras shall provide high resolution and high sensitivity suitable for operation in a power plant, both in natural and artificial lighted areas.

Detailed technical specification is given below.

a) **PTZ Dome Cameras**

High Definition (HD) PTZ cameras

Image Device	1/2.8-1/3" Progressive scan CMOS
Lens	4.45-4.7 /89-94.0 mm focal length
Optical Zoom	20x or better
Digital Zoom	12x or better
Number of Pixels/Effective resolution	1920X1080 (Full HD)/2 MP at 25/30 IPS
Video compression	H.264 Main Profile/High profile
Sensitivity(at 6dB)	color mode 0.6 lux , B/W mode 0.04lux @30IRE, F1.6
Horizontal Angle of view	55.4 deg(wide)- 3.5 deg (Tele) minimum
Focus	Auto with Manual Override
Iris Range	F1.6-F2.9
Iris Control	Auto with Manual Override
Back Light Compensation	Required
White Balance	Automatic with mode selection options
Electronic Shutter	1/50 to 1/10000 Auto
S/N Ratio	>50dB
Audio	Full Duplex or 2-way
Automatic Gain Compensation	Up to 18 dB
Power Supply	As per manufacturer's standard to be arranged by contractor
Gain Control	Auto/Off
Day/Night selection	Auto On-Off
IR cut-filter	Yes
Protocols	IPV4/IPV6,RTP, UDP, TCP, IP, HTTP, HTTPS, FTP, DHCP, IGMP V2/V3, ICMP, ARP, SMTP, SNTP,SNMP or equivalent.
Security	Password protection
Auto Resume after Power Failure	Yes
Multiple Streams	H.264 /H.264 & H.264/Motion JPEG

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Operating resolution	Primary stream – 1920X1080 at 25/30 FPS & other minimum 720X576 at 25/30FPS
Analytics	Motion detection & Tamper alarm
PoE supply IEEE 802.3af compliant or better	Yes
Rate Control	VBR/CBR
Other Features	
	On screen Menu display, contour correction and contrast compensation control
	Automatic Picture Enhancement to give a balanced picture where there is too much/too little light
	Synchronization selection for line lock and free running
	Minimum 2 Alarm I/Ps & 1 alarm output
PTZ Specifications	
Pan	360 Deg Continuous
Tilt	90 deg
Manual Tilt Speed	0.1 deg/sec to 45 deg/sec
Manual Pan Speed	0.1 deg/sec to 80 deg/sec
Preset Positions	Minimum 256
Preset Pan Speed	280 deg/sec min
Preset Tilt Speed	160 deg/sec min

b) Fixed Cameras

High Definition (HD) Fixed Camera

Image Device	1/2.8-1/3" Progressive scan CMOS
Number of Pixels	1920X1080 (Full HD)/2 MP at 25/30 IPS
Sensitivity(at f1.2,6dB)	0.21 Lux color & 0.05 Lux B/W(at 30IRE)
Lens	Varifocal Lens f=8-50 mm, CS-Mount
Lens Mount	CS-Mount
Focus	Auto with Manual Override
Iris Range	1.6 to 360
Audio	Full Duplex or 2-way

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IR cut-filter	Yes
Protocols	IPV4/IPV6,RTP, UDP, TCP, IP, HTTP, HTTPS, FTP, DHCP, IGMP V2/V3, ICMP, ARP, SMTP, Sntp,SNMP or equivalent
Security	Password protection
Iris Control	Auto with Manual Override
Analytics	Motion detection & Tamper alarm
PoE supply IEEE 802.3af compliant	Yes
SD/SDHC/SDXC in Camera (For Local alarm recording & scheduled local recording)	Yes ,minimum 32 GB capability
Rate Control	VBR/CBR
Back Light Compensation	Required
White Balance	Automatic with mode selection options
Electronic Shutter	1/50 to 1/10000 Auto
S/N Ratio	>50dB
Automatic Gain Compensation	Up to 18 dB
Power Supply	As per manufacturer's standard to be arranged by contractor
Gain Control	Auto/Off
Day/Night selection	Auto On-Off
Other Features	
	On Screen Menu Display, contour correction and contrast compensation control
	Automatic Picture Enhancement to give a balanced picture where there is too much/too little light
	Synchronization selection for line lock and free running
	Minimum One Alarm I/P Minimum One Alarm O/P

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<p>4.03.00</p> <p>4.03.01</p> <p>4.03.02</p> <p>4.03.03</p> <p>4.03.04</p> <p>4.06.00</p> <p>5.00.00</p> <p>5.01.00</p> <p>5.02.00</p>	<p>Camera Housing & Mount</p> <p>All the cameras and accessories are to be housed in Weather Proof IP 65 environmental housing made of aluminum and Sun shroud. The housing, with heater and blower installed, shall provide protection for camera/lens assemblies in the ambient temperature range of - 0 deg. C to 50 deg. C.</p> <p>For Non Dome type cameras, the housing shall also have thermostatically controlled heater kit. Continuous duty blower kit (with suitable filters) for purge air arrangement / Window wipers shall be available within the housing for cameras as indicated against each application.</p> <p>Keyboard & Joystick</p> <p>Keyboard shall have full function used for system control and programming for selection of various Network switches, camera/database servers, camera functions including pan, tilt and zoom lens controls and shall be ergonomically designed.</p> <p>Joystick shall be provided for achieving all control functions.</p> <p>Work Station</p> <p>Operator work station & network switch station shall be in Control Room or as finalized during the detailed engineering.</p> <p>WIRELESS CONNECTION EQUIPMENT (FOR CAMERA SPECIFIED ON WIRELESS CONNECTIVITY):</p> <p>Access points for these cameras shall be mounted on lighting mast. Wireless equipment and type of wireless connectivity shall be decided during detail Engineering.</p> <p>Wireless communication for the above should be subscribing the latest Cyber security standards including encryption. The wireless modem should support dynamic encryption techniques.</p> <p>CABLES :</p> <p>Cables shall be of FRLS PVC sheathed cables for use in CCTV and shall conform to latest edition of Indian/International standards. Fiber optic cables are to be provided (as applicable). The remaining cables can be as per CCTV supplier's standard. For details of Fiber Optic cables, refer subsection INST CABLE. All the cables and the hardware required for powering the system are also in the scope of Contractor. All cables required for interfacing alarm contact inputs (to be provided by employer) to CCTV system are also in scope of contractor.</p> <p>For estimation of cable quantities, erection hardware, hardware for wireless communication etc., the Bidder shall refer to General Layout Plant, Equipment Location Plans drawings & other relevant drawings to be finalized during detailed</p>
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engineering. All the cables are to be provided by the Contractor on as required basis.

No of CCTV Cameras & Type in each location

Sl	Location	Nos required	Type
1	Entry Gate(s) each	01	HD – Fixed
2	Security Room	01	HD - PTZ
3	Inverter Room (each)	01	HD - PTZ
4	CMCS Room entry	01	HD - Fixed
5	At strategic locations on the boundary	05	HD- Fixed
		05	HD- PTZ


Note: Location of the CCTV cameras shall be reviewed during detailed engineering


PART-D CIVIL WORKS

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<p>1.</p>	<p>GENERAL</p> <p>This chapter covers the Specific technical and functional requirements of civil works. The design calculations for MMS, RCC structure, PEB Invertor rooms, steel structures, foundation system, road work and drainage etc. shall be submitted for prior approval of NTPC before commencement of construction. The construction methodology for MMS and its foundations, road works, drains shall be also be submitted for prior approval of NTPC before start of works.</p> <p>All design of RCC and Steel structures shall be carried as per IS: 456 and IS 800 respectively and other specific code as applicable to specific structures.</p> <p>2.</p> <p>TOPOGRAPHICAL SURVEY</p> <p>Bidder shall conduct the Topographical Survey for the allocated plot in proposed solar project in Mandsaur district of Madhya Pradesh. The scope of work and technical specification for the same is as below:</p> <p>2.1.</p> <p>Scope of Work</p> <p>The Contractor shall carry out the Topographical Survey and preparation of Plans (Maps) and report of the assigned entire area/areas indicated for locating the Solar PV Power plant and its other systems.</p> <p>Carrying out the Bench Mark (GTS) to site/sites under survey by parallel levelling, establishing and constructing bench mark, grid and reference pillars in the field, and spot level survey of the entire area/areas at specified intervals and development of the contours.</p> <p>Carrying out cross-section of river/canal taking spot levels at on an average 20 meters intervals or less depending upon the site conditions.</p> <p>Furnishing all field data & drawings in soft copy (on CDs) apart from hard copies. Furnishing of the survey report as described in details in the succeeding paragraphs is also included in the scope of this work.</p> <p>The work shall be executed according to the specifications and good standard practice necessary to fulfill the objective of the survey work, strictly in accordance with the instructions and satisfaction of the Owner.</p>			
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2.2.	<p>The Contractor shall carry out Bench Mark by fly-levelling from nearest GTS Bench Mark or available source as approved by the Owner and establish the same two permanent Bench Mark at site. All subsequent transfer of levels shall be carried out with respect to these Bench Mark. The work shall also include constructing permanent reference pillars at suitably locations as approved by the Owner. These reference pillars shall be labelled permanently with their respective coordinates and reduced levels for future use. The Bench Marks and reference pillars shall be shown on the survey drawings.</p> <p>While carrying bench mark to the project site, levels shall be established on the permanent objects like culverts etc. at least on one object in every one km. if available along with route with adequate description about the objects and levels shall be maintained & mentioned in the survey report to facilitate locating these objects later on.</p> <p>Latitude and Longitude: The work shall be carried out in UTM grids system. The contractor shall also establish the latitudes and longitudes of the corners of the project site. At least 50m width of the adjoining plots shall also be covered in the survey for correlation with adjoining plots and adjacent area/facilities.</p>			
	<p>Topographical Survey and Mapping</p> <p>Positions, both in plan and elevation, of all natural and artificial features of the area like waterways, railway tracks, trees, cultivation, houses, fences, pucca and kutcha roads including culverts and crossings, foot tracks, other permanent objects like telephone posts and transmission towers etc. are to be established and subsequently shown on survey maps by means of conventional symbols (preferably, symbols of survey of India Maps), all hills and valleys within the area/areas are to be surveyed and plotted on maps by contours. Necessary levelling work of the entire area/areas are to be surveyed and plotted on maps by establishing horizontal location so that location and sketching of contours for the area/areas can be done at specified intervals and in specified scales on maps. Method of survey, contour intervals etc. shall be decided by owner on site in case of steep slopes and dense jungle etc. where gridding is not possible. Any unusual condition or formations on the ground, locations of rock outcrops (if visible on the surface) and spring/falls, possible aggregate deposits etc. shall also be noted and plotted on the maps.</p> <p>The field work shall be done with Total Station Equipment in the following steps:</p>			
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2.3.	<p>Establishing horizontal and vertical controls and locating reference grids and bench mark in the area. Surveying for establishing spot levels and plotting contours. Surveying for locating the natural and manmade details as described earlier.</p> <p>The grids for the survey work shall be established in N-S & E-W direction (Corresponding to Magnetic North) or the Plant North as directed by the Owner.</p> <p>Contouring</p> <p>Contractor shall carry out spot level surveying at an interval of on an average 25 meters for contouring the area. Levels shall also be taken on all traverse stations and on salient points located at random over the area (ground points). Contours are to be interpolated at 0.5 M intervals after the above points are plotted. The contours shall not be just interpolated but properly surveyed on the ground so that features falling between the two successive levels are also picked up. Sufficient points properly distributed over the entire area shall be located and levels taken so that accurate contouring can be done at places of sharp curvature or abrupt change in direction and elevation, points selected shall be close to each other. Salient points on ridge lines and valley lines shall also be measured.</p> <p>Transfer of levels shall always start from Main/Subsidiary stations whose levels are based on bench mark established in the survey area.</p>			
	2.4.	<p>Preparation & Submission of Survey Maps and Documents</p> <p>The Contractor shall submit survey maps of the site in 1:10,000 scale indicating grid lines and contour lines, demarcating all permanent features like roads, railways, waterways, buildings, power lines, natural streams, trees etc. The topography drawing shall also cover at least 50m wide area of the adjacent solar plot (beyond the assigned plot area) and match the grids of the adjacent solar plot.</p> <p>All the maps should be prepared in digitised forms using computer software like Autocad – Release 2005 or as directed by Owner. The block of name plate of all the drawings should be as per NTPC standard.</p> <p>Contractor shall submit all data pertaining to the survey in original to the Owner including all levels & co-ordinates in X-Y-Z format for the entire area on CD.</p> <p>Presence of any well and/or tube well in the site or adjoining areas and water level in them shall be marked in the documents. Details of earlier</p>		
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3.	<p>uses of the site i.e. mining, quarrying, agriculture etc. Existing drainage pattern of the site, possibility of water logging and high flood level of the area shall also be captured in the documents.</p>			
	<p>GEOTECHNICAL INVESTIGATION SCHEME</p>			
	<p>Geotechnical investigation for the scope of work shall be done by the bidder. The Bidder shall carry out geotechnical investigation for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Bidder shall obtain the approval for the field and laboratory testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.</p> <p>The detailed Geotechnical Investigation has to be carried out by the bidder in line with the Technical Specification. Bidder shall carry out the design of foundation etc. based on the approved geotechnical report.</p> <p>Field test shall include but not be limited to the following:</p> <p>Boreholes, Standard Penetration Test (SPT), collection of disturbed and undisturbed soil samples (UDS), Trial Pits (TP), collection of water samples, Electrical Resistivity Test (ERT) etc.</p>			
	<p>3.1. Scheme of Geotechnical Investigation</p>			
3.1.1)	<p>Minimum 1No. of borehole of 5m depth shall be carried out in every 12.5 acres of land. Few ERT & TPs shall be carried out as per layout.</p>			
3.1.2)	<p>The depth of boreholes shall be 5.0m. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery upto 20%, met within a borehole. This test shall be conducted at every 1.5 m interval or at change of strata. The starting depth of SPT shall be 0.5m from ground level. UDS shall be collected at every 1.5 m interval or at change of strata.</p>			
3.1.3)	<p>The laboratory tests shall be conducted on soil, rock & water samples collected during field investigations in sufficient numbers as approved by Employer. Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis,</p>			
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3.2.	<p>Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free Swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel. Laboratory tests on rock samples shall be carried out for Hardness, Specific Gravity, Unit Weight, Uniaxial Compressive Strength (in-situ & saturated), Slake Durability etc.</p> <p>On completion of all field and laboratory work, the Bidder shall submit a Geotechnical investigation report for Owner's approval. The Geotechnical investigation report shall contain field and laboratory observations/ data/ records, analysis of results and recommendations on type of foundation for different type of structures envisaged for all the areas of work. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc. shall also be covered in the report, as applicable.</p>			
	<p>Foundation System</p> <p>Foundation system for various facilities shall be designed and adopted as per approved geotechnical investigation report.</p>			
	<p>4. SITE LEVELLING AND GRADING</p> <p>Site levelling works involves the following works:</p> <div><div>1)</div><div>All works related to site clearance including removal of bushes, trees, levelling, grading, finishing and other additional works shall be carried out by the Contractor. Mandatory permission/licenses/statutory clearances from Competent Authorities for site levelling activities like removal of trees and bushes, undertaking blasting related works, disposal of cutting material etc. shall be obtained by the contractor.</div></div> <div><div>2)</div><div>Site grading level shall be fixed with due reference to site drainage of the whole area, existing drainage pattern, maximum flood level and system requirements.</div></div> <div><div>3)</div><div>Site levelling works/scheme shall match with the specific functional requirement of Solar PV optimum generation considering the full utilization of the plot area for the desired capacity.</div></div> <div><div>4)</div><div>Consideration from the boundary and fencing requirements.</div></div>			
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5.	<p>Based on the spot level, contour survey done and meeting above requirements, bidder can propose different site grade levels. The site levelling may be carried in patches/blocks. Bidder may also propose the site leveling and grading matching with the natural topography of the land considering the optimized use of the land , however bidder shall ensure to meet the desired power generation capacity in the allotted plot area. Bidder shall also ensure that no water ponding and flooding occurs in the low lying areas & effective drainage is provided in the whole plot area, in all kind of site levelling and grading or plant at natural topography schemes. After performing the optimization of levels from the detailed site survey by the Contractor, the final formation level of the plot in various areas shall be finalized. The area shall be suitably cut and filled to suit the layout requirement. The site levelling and grading scheme incorporating the above aspects shall be submitted to NTPC for approval.</p> <p>Fill shall normally be made up of Cohesive Non swelling material capable of being compacted upto 95% Modified Proctor density. In case earth has to be borrowed from outside the plant boundary, the same shall be arranged by the Contractor himself. The slope at the edge of graded areas shall not be flatter than 1:1.5 (1 vertical to 1.5 horizontal) in cutting and 1:2 in filling. In case of fill by rock material, the same shall be done in line with relevant Indian Standard.</p> <p>All buildings & switchyard area/sub-station area shall be constructed in levelled area. No foundation shall be allowed on back filled soil and in that case the depth of foundations shall reach up to NGL. Final Level will be approved in detail engineering.</p> <p>The slope protection measure shall be provided in case inter levelled patches level difference is more than 1.0m. Random rubble/boulder/stone pitching/concrete blocks etc. shall be provided for the slope protection for road side slope, storm water ditches/drainage, embankment slopes, inter levelled patches slopes etc. as per design requirements.</p>			
	<p>FENCING & MAIN GATE</p> <p>The chain link fencing shall compromise of G.I chain link fencing with mesh size 75x75 mm and of minimum 4 mm diameter and diameter of bare galvanised wire shall not be less than 2.5 mm as per IS 278. The chain link fencing material requirement shall confirm to IS: 2721. The chain link fence fabric shall have zinc coating of type “heavy” as given in IS 4826.</p> <p>The G.I. chain link wire mesh will be stretched and attached by clips to 3 strands of High Tensile Spring Steel (HTSS) wire of 4 mm dia interwoven in</p>			
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	<p>chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip will be threaded through the links of chain link and bolted to the fence post with the help of security nuts and bolts. All nuts, fasteners, bolts, clamping strips, clamps, clips, etc. shall be galvanized. Above the chain link fence three rows of galvanized reinforced twisted barbed tape with double edged profile, twisted around minimum 2.5mm galvanized bare wire shall be provided in the Half Y steel post at a maximum spacing of 175 mm c/c. Reinforced barbed tape will be attached to angle iron posts vertical height 400 mm. The type of section for fence shall be as mentioned in the fencing drawing and details of scope of work of fencing in plot layouts.</p>			
	<p>All fence posts shall be 75X75X6 MS angles spaced at 2.5 m c/c distance. All corner fence posts will have two stay posts in orthogonal directions and every tenth post will have a stay post in the direction of the fence. All stay posts shall be 75X75X6 MS angles. Concrete foundations for the angle iron posts and stays shall be provided as per the drawing. Toe wall shall be provided between the fence posts all along the run of the fence with foundation as per the drawing.</p>			
	<p>All MS angles conforming to IS 2062 used in posts shall also be galvanized in line with relevant codal provisions.</p>			
	<p>Suitable foundation/fencing arrangement shall be made in the fencing scheme to ensure intact fencing/safety in the water body/drains entry and exit points in the plot area. The same may be provided with a grid of MS angles of 50X50X6 sizes with foundation.</p>			
	<p>Mild Steel frame gate woven with chain linking having total span 4 m conform to IS: 2062 shall be provided. The gate shall be complete with guide track, castor wheel, all fitting and fixture like hinges, aldrops, locking arrangement, posts etc. The minimum size & requirements of the fencing and gate including all items shall be as per the fencing and gate tender drawing (Details of Chain Link Fencing Drawing No: 5714-004-POC-A-003, Rev B Details of Main Gate Drawing No: 5714-004-POC-A-004, Rev A). The width of approach road shall cover the gate width at the main entrance with suitable transition. All members used in gates shall be finished by cleaning of steel surfaces as per IS: 1477 (Part-II) and applying zinc chrome or zinc phosphate primer, followed by two coats of synthetic enamel paint. For finishing coat suitable colour pigment shall be added. All paints including primer shall be of reputed brand / manufacturer and as approved by the Engineer-In-charge. The method of application shall be as per the recommendations of the manufacturer.</p>			
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<p>6.</p> <p>6.1.</p> <p>6.2.</p> <p>6.3.</p>	<p>A minimum of two numbers of gates shall be provided for 50 MW plot and its location shall be approved by NTPC. One man movement passage gate (minimum 1.2m width) shall also be provided in one of the main gate.</p> <p>DESIGN CRITERIA FOR MODULE MOUNTING STRUCTURE (MMS) AND ITS FOUNDATION</p> <p>Scope:</p> <p>This section covers the loads and design requirement of the structures, racking, and all other items required to furnish and install a complete ground mounting structural system which constitute a photovoltaic array(s). MMS shall be adequately protected against all adverse climate conditions. The complete MMS, foundation and connections shall be designed & submitted for NTPC approval before start of work/fabrication.</p> <p>Design Loads:</p> <p>Dead Load: The load obtained by summing up the weight of modules and self-weight of Structure including Purlins, rafter/beams, Bracings, struts, columns, necessary fittings, etc. to be added as Dead load.</p> <p>Wind Load: The wind load (positive and negative) normal to surface on the modules and wind load on the structural members.</p> <p>The basic wind speed of the site shall be taken as 170 km/hr. Design wind speed factors shall be as per IS: 875-III, however the minimum value of these factors shall be considered as $K1 = 1.0$, $K2 = 1.0$ & $K3 = 1.0$ for the design of all Modules Mounting Structures (MMS).</p> <p>Materials Specification</p> <p>MMS frames, post, base plate, assembly of the array structures, etc. shall conform to Indian standards as mentioned in the list of code.</p> <p>IS: 2062 - Hot Rolled Medium and High Tensile Structural Steel IS: 811 - Cold Formed Light Gauge Structural Steel Sections IS: 1161- Steel Tubes for Structural Purposes IS: 4923 - Hollow steel sections for structural use</p> <p>However, Bidder can also propose new light gauge structural steel or structural aluminium members other than specified in specific Indian standards code and subjected to approval by NTPC. Minimum thickness of</p>	
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6.4.	<p>MMS column post shall be 3.15 mm and the minimum thickness of light gauge members shall be 2 mm.</p> <p>All materials shall be fabricated in shop such that welding in the field shall not be required.</p> <p>Connections</p> <p>All fasteners (nuts, bolts and washers) shall be of Stainless steel (SS304). All bolts shall be tighten with designed torque mechanically.</p> <p>In the ground mounting structure system with seasonal tilt arrangement, the column post and rafter/beam at seasonal tilt point of rotation shall be hinge plate and bolt system.</p> <p>MMS column post with base plate anchor bolted connections in foundations shall be provided with galvanized high strength “J” bolts conforming to specifications of IS:4000 / IS:1367 and relevant IS code.</p>			
	6.5.	<p>Coating For Structural Steel Works</p> <p>MMS frames, post, base plate, assembly of the array structures, etc. shall be of MS hot dip galvanized. Hot dip galvanization shall be as per IS: 4759 or relevant Indian standard and the coating minimum thickness shall be maintained by 85 micron. In case offered support is made up of Aluminium, anodized coatings on aluminium as per IS: 1868 (Gr AC25) shall be provided for mounting structure.</p> <p>IS: 4759 - Hot-dip zinc coatings on structural steel and other allied products IS: 4736 - Hot-dip zinc coatings on mild steel tubes IS: 1868 - Anodic coatings on aluminium and its alloys.</p>		
		6.6.	<p>Design Parameters</p> <p>The Ground mounting structure system which constitute a photovoltaic array(s) shall be designed to withstand the extreme fair wind (positive pressure) and adverse wind (negative pressure) on design tilt angle of solar photovoltaic array(s).</p> <p>The design calculations shall be supplemented with neat sketch and reference to various clauses of Technical specification and Indian standards. For MMS design analysis and determination of forces, where computer program (preferably STAAD) is used, the contractor shall submit</p>	
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	<p>a write-up on computer program used and its input and output data for review and approval of Engineer-in-Charge</p> <p>An increase in allowable stresses of structural materials should not be considered during design analysis.</p> <p>Wind pressure for following loads shall be considered as follows:</p> <div><div>(1) Dead Load of steel with all members, fittings & panels.</div><div>(2) Load due to fair wind direction on design tilt angles of solar mounting structural members.</div><div>(3) Load due to adverse wind direction on design tilt angles of solar mounting structural members.</div><div>(4) Load on side face of mounting structural members.</div></div> <p>Wind pressure coefficient, load and load combination shall be as per Indian standards (latest revision) such as IS: 875, IS: 800. The load (4) shall be considered with load (2) and load (3) in relevant load combination.</p> <p>Design analysis and the forces on MMS (Compressive force, uplift force, shear and moment) shall be used for design of foundation system.</p>			
	6.7.	<p>Vertical Deflection And Horizontal Sway Limits</p> <p>Limiting Deflection: The limiting permissible vertical deflection for structural steel members shall be as per: Maximum vertical deflection in purlin = Span/180, Maximum vertical deflection in rafter (cantilever span) = Span/180 and Maximum lateral deflection in column post = Height/240</p>		
6.8.	<p>Foundation System</p> <p>Top of concrete/ height of collar for MMS foundation shall be minimum 250 mm above FGL. The minimum plan area /section area of MMS foundation collar shall be 700 sq.cm.</p> <p>The proposed foundation system for MMS shall be based on findings/results of the approved geo technical investigation. Following kind of foundation may be provided:</p> <div><div>1) Short pile RCC foundation (Min. 300mm dia.)</div><div>2) Rock anchor with concrete collar</div><div>3) Isolated, strip or raft foundation</div><div>4) Concrete ballast foundation</div></div>			
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7.	CMCS, INVERTER ROOMS & SECURITY ROOM			
	<p>The following structures shall be designed and provided by the bidder:</p> <p>(I) CMCS Building :For the operation and maintenance of SPV Plant one Central Monitoring and Control Station (CMCS) with 33 KV switchgear room shall be provided. The CMCS building shall consist of the following:</p> <ul style="list-style-type: none">1. Air conditioned SCADA Room (area minimum 16 sqm) (located on CMCS building first floor)2. Inverter room as per requirement3. ACDB, Battery and Switchgear Room4. Store Room (min 20 sqm)5. Toilet and Urinal (min 7.5 sqm) <p>Inverter(s), battery room, ACDB and Switchgear room shall be based on manufacturer recommendation, easy passage of O&M persons and cable trench layout required. The CMCS shall be RCC framed structure with bricks/concrete blocks masonry walls. The CMCS shall have entry lobby and portico with roof for vehicle stoppage. The SCADA room as mentioned at sl. no. 1 with one toilet shall be planned on first floor and shall be designed to have clear view through glass windows on all sides. Suitable RCC staircase with roof shall also be provided for access of first floor SCADA room. One toilet connected with main control room shall be provided at first floor.</p> <p>(II) Inverter Rooms: Inverter rooms consist of PCU's, LT panels, batteries, etc. shall be provided based on manufacturer recommendation, easy passage of O&M persons and cable trench layout required. The inverter rooms shall be made of Pre-Engineered Building (PEB) in line with PEB technical specification as mentioned in the document.</p> <p>(III) Security Room: One prefab security room (4 sqm) near the entry gate with brick/stone masonry toilet and water facility. The drawing and the design of the prefab security room and its toilet system shall be approved from NTPC.</p> <p>The layout, design and drawings for all RCC/PEB structure, etc. and foundation system shall be approved from NTPC before start of works. The buildings and allied works shall be designed to meet national building code 2005 requirements.</p>			
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7.1.	<p>Specification for RCC Building for CMCS</p> <p>The CMCS building shall be made of RCC framed structure with bricks/concrete blocks masonry walls. The thickness of outer masonry walls shall be minimum 230mm in case of bricks and minimum 200mm thick in case of concrete blocks. The following detailed specification shall also be followed for RCC works:</p>	
7.1.1.	<p>Floor Finishes</p> <div style="margin-left: 20px;"> Switchgear/Inverter rooms : Cement concrete flooring with ironite hardener. SCADA room : Heavy duty vitrified ceramic tiles Battery room : Acid/Alkali resistance tile flooring and dado (2100 mm) Lobby : Heavy duty vitrified ceramic tiles and skirting Toilet : Heavy duty anti-skid ceramic Tiles and dado 2100 mm Steps : Kota stone/Granite- 20 mm thick Store room : Cement concrete flooring with ironite hardener. </div> <p>Flooring for air conditioned areas area shall be provided with vitrified ceramic tiles of size 600X 600 mm of min 9 mm thickness, laid with 3 mm ground joints as per approved pattern. Cement concrete flooring shall conform to IS 2571.</p> <p>The floor finish for toilet shall be vitrified ceramic anti-skid tiles and Dado glaze ceramic tiles upto 2.1m shall be used. The normal size of Ceramic tiles shall be 300 mm X 300 mm X 9 mm and shall comply IS: 15622.</p> <p>Finish floor level of all building shall be minimum 450 mm above from Finish graded level</p>	
7.1.2.	<p>False Ceiling</p> <p>The SCADA room shall be provided with false ceiling of 15 mm thick mineral fibre board, in tile form of size 600mm x 600mm, along with galvanised light gauge rolled form supporting system in double web</p>	
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7.1.3.	<p>construction pre painted with steel capping, of approved shade and colour, to give grid of maximum size of 1200x600 mm as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts(if required), return air grills(if required), light fixtures, etc., all complete.</p>			
	<p>Roof Finishes Roof of the Building shall consist of Cast-in-situ RCC slab treated with a water proofing system. The roof of the building shall be water proof with Polymeric membrane type waterproofing as per DSR 2013, Items no. 22.16. The roof shall be designed for minimum superimposed load to 150 kg/m2.</p> <p>For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100 and the roof shall be provided with RCC water gutter, wherever required. Gutter shall be made water tight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface. The roof of all building shall be projecting out by at least 750 mm all around the building for its external walls protection from rain water and parapet wall above the roof beam. Height of parapet wall shall be minimum 300 mm above top of roof level. Structural steel hand railings of minimum 700mm height shall also be provided over the parapet wall. The bidder shall also provide structurally adequate rain water harvesting system in order to ensure rain water harvesting.</p>			
	<p>7.1.4. View point RCC terrace of CMCS building shall also work as view point. View point shall be used for security purposes and viewing gallery. Suitable staircase with hand railings and foundation shall be provided for access to roof of the RCC CMCS building.</p>			
7.1.5.	<p>Windows, Doors, Ventilators and Rolling Shutters Doors, windows and ventilators of air-conditioned areas, entrance lobby of all buildings, and all windows and ventilators of CMCS building shall have, powder coated (minimum thickness of powder coating 50 micron) aluminium framework with glazing. Window shall be provided with suitable aluminium grill.</p>			
	<p>All doors of toilet areas shall be of steel framed solid core flush shutter as per IS 2202. Minimum size of door provided shall be 2.1 m high and 1.2 m</p>			
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7.1.6.	<p>wide. However for toilets minimum width shall be 0.75 m and office areas minimum width shall be 1.20 m.</p> <p>Doors and windows on external walls of the buildings (other than areas provided, with insulated metal claddings) shall be provided with RCC sunshade over the openings with 300 mm projection on both side of the openings. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings except for main entrance door to the control room where the projection shall be 1500mm</p> <p>Rolling shutter (Mechanical gear operated). Rolling shutters shall be fabricated from 18 gauge steel and machine rolled with 75 mm rolling centres with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast iron clips to IS: 2108 and shall be designed to withstand a wind load without excessive deflection. Metal rolling shutters and rolling grills as IS: 6248</p>														
	<p>Glazing</p> <p>All accessible ventilators and windows of all buildings shall be provided with min. 4mm thick float glass, tinted for preventing solar radiations, unless otherwise specified.</p> <p>For single glazed aluminium partitions and doors, toughened float glass of 10 mm thickness shall be used. All glazing work shall conform to IS: 1083 and IS: 3548.</p> <p>The glass to used should be from reputed brand / manufacturer and as approved by NTPC. The glass should be free from distortion and thermal stress.</p>														
	<p>7.1.7. Paintings of wall and ceilings</p> <table><tr><td>Internal wall surfaces:</td><td></td></tr><tr><td> SCADA room</td><td>- Acrylic Emulsion</td></tr><tr><td> All other rooms in plant buildings</td><td>- Oil bound distemper</td></tr><tr><td>External faces of walls:</td><td>- Exterior emulsion paint</td></tr><tr><td>Walls of battery room</td><td>- Chlorinated rubber paint, an exposed walls above Dado - 2100 mm high Dado of Acid / Alkali resistant tiling.</td></tr><tr><td>All Ceiling</td><td>- Oil bound distemper (office rooms without false ceiling), Acid resistant resin based Epoxy coating (Battery rooms), and White</td></tr></table>				Internal wall surfaces:		SCADA room	- Acrylic Emulsion	All other rooms in plant buildings	- Oil bound distemper	External faces of walls:	- Exterior emulsion paint	Walls of battery room	- Chlorinated rubber paint, an exposed walls above Dado - 2100 mm high Dado of Acid / Alkali resistant tiling.	All Ceiling
Internal wall surfaces:															
SCADA room	- Acrylic Emulsion														
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7.1.8.	washing (all other areas)			
	The paint shall be anti-fungal quality of reputed brand suitable for masonry. All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller. For painting on concrete, masonry and plastered surface, IS: 2395 shall be followed. Minimum 2 finishing coats of paint shall be applied over a coat of primer.			
	For painting on steel work and ferrous metals, BS: 5493 and IS: 1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.			
	Ceiling of all rooms except Battery room shall be white washed. The ceiling of Battery room (if provided) shall be acid/alkali resistant paint.			
	A standard colour scheme for the different buildings/structures shall be prepared by the Contractor and the approval of the Owner shall be obtained, before commencement of work.			
	Plumbing and sanitary			
	CMCS room shall have attached toilet for both Gender. Each toilet shall have the following minimum fittings.			
	(a) Wall mounted WC (Western type) 390 mm high with toilet paper roll holder and all fittings			
	(b) Wall mounted Urinal (430 x 260 x 350 mm size) with all fittings for male toilet only.			
	(c) Wash basin (550 x 400 mm) above platform with all fittings.			
	(d) Bathroom mirror (600 x 450 x 6 mm thick) hard board backing			
	(e) CP brass towel rail (600 x 20 mm) with C.P. brass brackets			
	(f) Soap holder and liquid soap dispenser			
	All fittings, fastener, grating shall be brass with chromium plated as per relevant IS code. Necessary plumbing lines shall be provided for CMCS room building and Security room near main gate.			
	The bidder shall design & provide packaged sewerage treatment plant for CMCS and Security room assuming that a total of 15 people shall use the facility.			
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7.2.2.	Insulated wall cladding or roofing shall consist of double skin metal cladding with Poly Urethane Foam (PUF). PUF must be made of continuous method PU foam and must be CFC free, self-extinguishing, fire retardant type with density 40 +/-2 kg/m3 and thermal conductivity 0.019-2.2 W/(m.K) at 10°C. The PUF panels shall be a factory made item ready for installation at site.			
	Fasteners & Connections:			
	Special coated self-drilling screws/fastener shall be used conforming to class 3 as per AS: 3566.1 and AS: 3566.2. Steel bolts, nuts and washers complying with AS 1112:2000. High Strength Bolts for Primary Connections IS: 1367 (Part III) Gr. 8.8 / ASTM A325. Bolts for Secondary Connection IS: 1367 (Part III) Gr. 4.6 / ASTM A307. Anchor/foundation Bolts shall conform to IS: 5624 and relevant IS code.			
7.2.3.	Roof and Wall cladding:			
	PUF panels shall be made of troughed permanently colour coated metal sheets of steel for roofing and side cladding (internal and external) shall conform to the requirements of Table-1 and IS: 513 for Hot-dip Zinc coated or Al/Zn coated sheets. The insulation material thickness and details shall be as specified at relevant para in the specification.			
	PUF insulated panels Metal Sheet for Roofing and side cladding consist of external sheet as troughed permanently colour coated sheet & internal sheet as plain permanently colour coated sheet.			
	Chemical composition of Troughed permanently colour metal sheet for roofing and side cladding shall conform to the provisions of same reference code to which the mechanical properties conform to.			
	Plain permanently colour coated steel metal sheet for ridge and hips, flashing, trimming, closure for vertical and horizontal joints, capping etc. shall conform to the same requirements as those of troughed permanently colour coated metal sheet for roof and side cladding.			
	The maximum spacing of the fastener shall be 390 mm c/c along the length of purlins / runners. However exact spacing shall be as per the design done by the bidder of the fastener considering the wind load, self-load and other associated load. Minimum diameter of the fastener shall be 5.5 mm and at-least 3 nos. of fastener shall be used per sheet.			
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7.2.4.	Fillers blocks as a trough filler shall be used to seal cavities formed between the profiled sheet and the support or flashing. The fillers blocks shall be manufactured from black synthetic rubber or any other material approved by engineer.			
	Roof Insulation and type:			
	7.2.4.1	Both metal sheets shall have an under insulation of minimum 80 70-mm thick PUF with density 40 +/- kg/m ³ and thermal conductivity 0.019-2.2 W/(m.K) at 10°C with gutters and down take pipes along with Flashing & Top cap of required size and colour complete with all necessary hardware complete. Roof shall be projected at-least 300 mm from the wall.		
	Stiffening ribs / subtle fluting for effective water shedding and special male / female ends with full return legs on side laps for purlin support and anti-capillary flute in side lap.			
	Both upper and lower sheets shall be separated through spacers and fastened through zinc /zinc-tin coated self-drilling screws. The fastener size shall be calculated as per the design or manufacturers recommendations.			
	7.2.4.2	Bidder may also alternatively made the PEB roofing with composite slab (RCC slab with permanent formwork). The composite slab scheme, design and drawings shall be subject to approval from NTPC before start of work.		
7.2.5.	Wall Insulation:			
	All voids of external and internal metalled walls shall have an under insulation of minimum 60 mm thick PUF with density 40 +/- kg/m ³ and thermal conductivity 0.019-2.2 W/(m.K) at 10°C with proper supports etc. as approved.			
	Both the walls should be separated by spacers system made up of cold formed steel bars and fastened through zinc /zinc-tin coated self-drilling screws.			
7.2.6.	The external wall of Inverter room facing the transformer area shall be as per IS: 1646 - Code of practice for fire safety of buildings (general): electrical installations.			
	Doors Frames:			
	Door frames shall be of T-iron frame of mild steel Tee-sections as per DSR-2013 item no 10.13. All doors shall be provided necessary fittings like			
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	<p>hinges, handles, mortice locks, tower bolts, stopper, hydraulic door closer, etc. of CP brass complete.</p> <p>Black powder coated aluminium doors shall be with extruded built up standard tubular sections, appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixed to Pre-Engineered structure including necessary filling up of gaps at junctions with required PVC/neoprene felt etc. including hinges / pivots and double action hydraulic floor spring of approved brand and manufacture IS: 6315 marked, lock, handle and all necessary fittings as detailed in tender drawing or submitted by bidder in shop drawing and approved by NTPC</p> <p>The door entrance shall include Mild Steel single leaf door. The structural steel shall conform to IS: 7452 and IS: 2062. The holdfasts shall be made from steel flats (50 mm and 5 mm thick). The fixtures, fastenings and door latch are to be made with same materials.</p>			
	7.2.7.	Windows Frame:		
		<p>Aluminium black powder coated section, frame shall be of 92x31 mm, minimum 16G thick as per approved design. Tinted glass and aluminium grill shall be provided.</p>		
	7.2.8.	Ventilators:		
	<p>Aluminium black powder coated frame of minimum size 62x25 mm and 16G thick as per approved design. Ventilators/duct shall be provided with bird guard. Size of opening at wall for ducts shall be as per PCU manufacture and min 18 gauge GI sheet. Ducts shall be supported with suitable means, as approved during detail engineering.</p> <p>All accessible ventilators and windows of all buildings shall be provided with min. 4mm thick float glass, tinted for preventing solar radiations. Suitable sunshades made out of approved colour sheet will be provided to all external windows and door. The minimum projection for the sunshades will be 450 mm and 300mm wider than the width of the opening.</p>			
	7.2.9.	Rolling shutter:		
	<p>Rolling shutter (Hand operated) shall be fabricated from 18 gauge steel and machine rolled with 75 mm rolling centres with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast iron clips to IS:2108 and shall be designed to withstand a wind load without excessive deflection. Metal rolling shutters and rolling grills as IS: 6248.</p>			
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7.2.10.	Plinth Protection:			
	750 wide plinth protection minimum 75 mm thick of cement concrete 1:3:6 (1cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) over 75 mm bed of dry brick ballast 40 mm nominal size well rammed and consolidated and grouted with fine sand including finishing the top smooth, shall be provided around the Pre-Engineered Building.			
	7.2.11.	Floor Finish:		
		Flooring, including preparation of surface, cleaning etc. shall be of cement concrete flooring as per IS: 2571 with ironite hardener. The inverter room floor shall be at least 450 mm above the ground level.		
	7.2.12.	Paint and Coating:		
Steel shall be colour coated with total coating thickness of 25 microns (nominal) dry film thickness (DFT) comprising of silicon modified polyester (SMP with silicon content of 30% to 50 %) paint or Super Durable Polyester (XRW) paint of 20 microns (nominal) on one side (exposed face) on 5 micron (nominal) primer coat and 10 microns (nominal) SMP or Super Durable Polyester paint over 5 micron (nominal) primer coat on other side. SMP and polyester paints system shall conform to Product type 4 as per AS/ANZ 2728.				
7.2.13.	The structural steel shall be hot-dipped galvanized, conform to IS: 4759 or relevant Indian standard			
	Lighting:			
7.2.14.	The inverter room shall be provided with electric light to achieve average illumination level of 150 Lux. However room should be designed to utilize maximum natural light during the day.			
	Design Parameters and Design Loads:			
	The structure shall be designed for loads and load combination as per Indian Standards (latest revisions) such as IS: 875, IS: 1893, IS: 800, IS: 456 etc.			
	Dead Load: Self Weight of Structure including Purlins, Sheeting, Girts, Bracings, weight of turbo ventilators to be added as Dead load etc.			
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7.2.15.	<p>Imposed Load (Live Loads) Live loads shall be as per IS – 875. For sloped roofs up to 10 deg. it shall be 0.75 KN/M².</p> <p>Wind Load: The basic wind speed of the site shall be taken as 170 km/hr. Design wind speed factors shall be as per IS: 875-III, however the minimum value of these factors shall be considered as K1 = 1.0, K2 = 1.0 & K3 = 1.0 for the design of PEB.</p> <p>Earthquake Load: All PEB structures shall be designed for Seismic forces.</p> <p>Vertical Deflection and Horizontal Sway Limits:</p> <p>a) Limiting Deflection: The limiting permissible vertical deflection for structural steel members shall be as per IS 800 2007.</p> <p>b) The limiting permissible horizontal deflection for as per IS 800 2007 code where 'h' is height of building at eaves.</p> <p>Descriptions of PEB Structures:</p> <p>Primary Members: Primary structural framing shall include the transverse rigid frames, columns, corner columns, end wall wind columns, beams, truss member, base pate.</p> <p>Secondary Members: Secondary structural framing shall include the purlins, girts, eave struts, bracing, flange bracing, base angles, clips, flashings and other miscellaneous structural parts. Suitable wind bracings sag rods to be reckoned while designing the structure.</p> <p>Sealant: Sealant used for cladding shall be butyl based, two parts poly sulphide or equivalent approved, non-staining material and be flexible enough not to interface with fit of the sheets.</p> <p>Closures: Solid or closed cell closures matching the profiles of the panel shall be installed along the eaves, rake and other locations</p> <p>Flashing and Trim: Flashing and / or trim shall be furnished at the rake, corners, eaves, and framed openings and wherever necessary to provide weather tightness and finished appearance. Colour shall be matching with the colour of wall. Material shall be 26 gauge thick conforming to the physical specifications of sheeting.</p> <p>Gutters and Down Comers: Gutters shall be fabricated out of same metal sheet. Material shall be same as that of sheeting. Down comers shall be of</p>			
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	galvanized steel pipes or PVC designed to ensure proper roof drainage system.									
	Table-1									
Group	Grade/Referenc e code	Yield strength (minimu m) MPa	Tensile strength (minimu m) MPa	Coating Class Designati on	BM T (m m)	(+) ve Toleranc e (mm)	Upper limit of BMT (mm)	(-) ve Toleranc e (mm)	Lower Limit of BMT (mm)	
I	G250/ AS1397	250	320	Z275	0.6	0.04	0.64	-0.04	0.56	
	SS255/ ASTM A653M	255	360							
	S250GD / EN1032 6	250	330							
II	G350/ AS1397	350	420	AZ150	0.5	0.04	0.54	-0.04	0.46	
	SS340CI ass 4/ ASTM A792M	340	410							
	S350GD / EN1032 6	350	420							
NOTE:	Minimum elongation % shall be as per relevant Standard and Code.									
8.	All steel materials supplied by the Agency shall be in a sound condition, of recent manufacture, free from defects, loose mill scale, slag intrusions, laminations, pitting, flaky, rust, etc. and be of full weight and thickness specified.									
8.1.	GENERAL CIVIL WORKS									
	Water Supply									
	GI pipes of Medium quality conforming to IS 1239 (Part I-1990) shall be used for all water supply and plumbing works.									
	The Syntax or equivalent make PVC storage water storage tank conforming to IS: 12701 shall be provided over the roof of the CMCS with adequate capacity for 10 No person and 24 hr requirement, complete with all fitting including float valve, stop cock etc. The capacity of the tank shall be minimum 500 litres. The over roof water tanks shall have suitable									
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8.2.	Plastering			
	<p>All external surfaces shall have 18 mm cement plaster in two coats, under layer 12 mm thick cement plaster 1:5 and finished with a top layer 6 mm thick cement plaster 1:6 (DSR 2013-13.11).</p> <p>White cement primer shall be used as per manufacturer’s recommendation.</p> <p>At least one coat of plaster shall be applied to interior walls by hand or mechanically, to a total thickness of 12 mm using 1:6, 1 cement and 6 sand. Plastering shall comply to IS: 1542, IS: 1661, IS: 1630. Oil bound washable distemper on smooth surface applied with minimum 2 mm thick Plaster of Paris putty for control room. Plaster of Paris (Gypsum Anhydrous) conforming to IS: 2547 shall be used for plaster of paris punning.</p>			
8.3.	Masonry Work			
	<p>All brick works shall be using at least class designation 7.5 of approved quality as per IS: 1077, IS: 2212 and IS: 3495. All concrete blocks shall be of minimum compressive strength of 7.5 N/mm2 and shall be of Grade-A as per IS: 2185. All stone masonry work shall be ashlar masonry work with stone of minimum compressive strength of 7.5 N/mm2. The stone masonry work shall be in line with IS: 1597, IS: 1122 and IS: 1126.</p> <p>The cement mortar for all kind of masonry work shall be in the ratio 1 cement and 5 sand by weight.</p> <p>Bricks/blocks required for masonry work shall be thoroughly soaked in clean water tank for approximately two hours. Brick shall be laid in English bond style. Green masonry work shall be protected from rain. All masonry work shall be kept moist on all the faces for a period of seven days.</p> <p>The external wall for the building shall be 230 mm thick walls and internal wall 230/115 thick as per requirements. The external wall of CMCS facing the transformer area shall be as per IS: 1646 - Code of practice for fire safety of buildings (general): electrical installations.</p> <p>Use of fly ash brick for masonry shall be subjected to approval of NTPC.</p>			
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8.4.	Suitable damp proof course shall be provided the proportion of cement, sand & aggregate shall be 1:2:4 using 6 mm down stone chips with a water proofing admixtures. The thickness of damp-proof course shall be minimum 40 mm.			
	Reinforced Concrete Structure, Allied Works and Foundation			
	All RCC works shall be design mix as per IS: 456-2000. For structural concrete items, Ordinary Portland cement (43 Grade) conforming to IS: 8112 and Fly ash based Portland pozzolana cement conforming to IS: 1489 (Part-1) shall be used for superstructure. Type of cement for sub-structures shall be decided based on the final Soil Investigation report.			
	Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.			
	Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS: 383. For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116			
	Reinforcement steel shall be of high strength deformed TMT steel bars of grade minimum Fe-500 and shall conform to IS: 1786. Ductile detailing in accordance with IS: 13920 shall be adopted for superstructure and substructure of all RCC buildings / structures			
	The following minimum grades of concrete for design mix and nominal mix shall be adopted for the type of structures noted against each unless not specified elsewhere.			
	M 25 - All RCC structural elements above and below ground level, precast concrete, MMS foundation, cable trench, oil pit, Grade Slab, Paving, culverts & road.			
	M-20 (Equivalent nominal Mix of 1:1.5:3)* - Fencing work			
	M-15 (Equivalent Nominal Mix of 1:2:4) - Base slab of drains.			
	M-10 (Equivalent Nominal Mix of 1:3:6) - Plain Concrete Cement.			
	The bidder shall carry out the design mix of M-25 and M-20 grade concrete on priority. The design mix shall be approved from NTPC before start of work.			
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	<p>* The use of nominal mix for M-20 grade may be accepted only in exceptional cases subject to approval of NTPC. The same shall be adopted subject to approval from NTPC for specific work.</p> <p>In case Geotechnical investigations requires any special kind of cement or higher grade of concrete, the same shall be provided.</p> <p>The foundation system shall be made which transfer loads safely to the soil for the module mounting structures, depending on soil conditions, geographical condition, regional wind speed, bearing capacity, slope stability etc. All foundation system and foundation depth shall be decided based on the approved geotechnical investigation report. No foundation allowed on back filled soil and the foundation depth to reach upto NGL.</p> <p>All loads shall be considered in line with IS: 875. Seismic loads for design shall be in accordance with IS: 1893 and relevant Standards.</p> <p>IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete Reinforcement must be complied for reinforcements. IS: 5525 and SP: 34 shall be followed for reinforcement detailing.</p> <p>A minimum 75 mm thick PCC shall be provided below RCC wherever RCC is laid over the ground. Proper and sufficient formwork/shuttering shall be provided for the required period as per IS: 456.</p>			
	8.5.	Structural Steel		
	All structural steel shall design shall carried out as per IS 800. Structural steel shall conform IS 2062, Pipe shall be as per medium/high grade of IS 1161, Chequered plates shall conformed to 3502 and Hollow steel sections for structural use shall conform to IS: 4923.			
	8.6.	Grouting		
	Cement mortar (1:2) grout with non-shrink additives shall be used for grouting below base plate of column. The grout shall be high strength grout having a minimum characteristic compressive strength of min 30 N/mm2 at 28 days.			
8.7.	Transformer Yard Civil Works			
Transformer and equipment's foundations shall be founded on piles/isolated spread footings depending on the final geotechnical investigation report.				
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8.8.	<p>Transformer foundations shall have its own pit which would cover the area of the transformer and cooler banks, so as to collect any spillage of oil or oil drainage in case of emergency. The oil pit shall be filled with granite stones of 40 mm size uniformly graded.</p>			
	<p>The individual oil pits shall be connected to an oil collection pit which shall be sized to accommodate oil volume of the transformer connected to it, without backflow. The oil pit shall be connected to oily water drainage system. Dimensions of the discharge pipe shall consider rainfall intensity also. The water shall be discharged into the nearest drain by gravity flow or pumping.</p>			
	<p>The area around the transformer and equipment's shall be covered with gravel and galvanised chain link fence of height min 1.8 m with fence posts and gates shall be provided. All fence posts shall be 50X50X6 MS angles spaced at 2.5m c/c distance and all other specification mentioned at clause no. 5 for Fencing and gate shall be followed. M.S. angle posts shall conform to IS: 2062. The portion of the fence covering towards rail track shall be made of removable type for movement of transformer during erection /removal. In addition a small gate, 1.2 m wide shall be provided for man entry. The transformer yard fencing work shall conform to CEIG requirements.</p>			
	<p>Transformer track rails shall conform to IS: 3443. The requirement of fire barrier wall between transformers shall be as per Electricity Rules and IS: 1646 recommendations.</p>			
	<p>Pipe /Cable Racks & Trenches</p>			
	<p>Trenches shall be constructed in reinforced cement concrete of M-20 grade of wall thickness min 150 mm. The top of trenches shall be kept at least 100 mm above the gravel level so that rain water does not enter the trench. Trench walls shall not foul with the foundations.</p>			
	<p>Outdoor Cable Trenches: RCC cable trenches shall be constructed in the switchyard and pre-cast RCC removable covers with lifting arrangement, edge protected with suitable galvanized angle iron designed to withstand self-weight of top slab + concentrated load of 150 kg at center of span on each panel.</p>			
	<p>Indoor Cable Trenches: RCC indoor cable trenches shall be provided with 50X50X6 mm angles grouted on the top edge of the trench wall for holding minimum 7 mm thick mild steel checkered plate covers (600 mm in length</p>			
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9.	<p>except at ends & bends) with lifting arrangement. Angle or channels shall also be grouted at distances of 600 mm across the indoor cable trenches to support the checkered plates.</p> <p>Trench Drainage: The trench bed shall have a slope of approx. 1/500 along the run & 1/250 perpendicular to the run. In case straight length exceeds 30 m, suitable expansion joint shall be provided at appropriate distances. The expansion joint shall run through vertical wall and base of trench. All expansion joints shall be provided with approved quality PVC water stops. Suitable drainage at lowest point of the trench shall be provided.</p>			
	<p>ROAD AND PATHWAY</p> <p>9.1. Road: The approach road to the Solar Power Plant shall originate from the main approach road and connect to all Inverter room and CMCS building. Approach road shall be 3.0 meter wide with 1meter wide shoulder on both side. Red moorum/brick, minimum 100 mm thick shall be provided for shoulder. The crown of the road shall be minimum 250 mm above FGL. The final finished roads shall have a camber of 1 in 50.</p> <p>The minimum road section shall be as follows:</p> <ul style="list-style-type: none">1) Topping: Wearing course of premix carpet 20 mm thick.2) WBM, compacted 75 mm thick Grade III.3) WBM, compacted 100 mm thick Grade II.4) Granular Sub-base, compacted 250 mm thick granular sub-base (Grade-I).5) Sub-grade under road and its shoulders shall be compacted to achieve 95% or more of standard proctor's MDD. CBR value of the sub grade level should be minimum 4%. If actual CBR is less than 4% in a particular stretch then the same material shall modified with increase in GSB thickness. <p>The methodology of road construction with material specifications shall be in line with IRC/MORTH and shall be submitted for NTPC approval before start of works. Typical detail of Approach Roads drawing no: 5714-004-POC-A-002, Rev-A.</p>			
9.2.	<p>Pathways: Pathways width shall be 1 meter. Pathways shall be provided between each row of MMS. The pathways shall be levelled and compacted for carrying panels, carrying materials, MMS washing, easy movement of O&M, etc.</p> <p>Pathways shall be compacted manually/ mechanically. Wherever the grass/roots are found in the pathways, same shall be removed upto depth</p>			
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10.	<p>of 200 mm & the ground shall be levelled and compacted. The finished pathways shall ensure easy movement of motorable bike and avoid any growth of vegetation.</p> <p>Pathways surface shall be levelled by minimum 100 thick PCC (1:3:6), wherever change in topography/ground slope is steeper than 1:6. The PCC layer shall match the ground topography.</p>			
	<p>DRAINAGE SYSTEM</p> <p>Surface drainage system shall be designed considering the maximum hourly rainfall intensity as per IMD. However, the minimum value of “maximum hourly rainfall” shall not be less than 60 mm”. The value of surface run off coefficient shall not be considered less than 0.6 in the design of drainage system. The drainage system shall be designed as per the IRC specifications and prevailing industry practices. The drainage scheme shall be designed considering the bidder’s plot area and nearby catchment area contributing to the plot drains. Drainage scheme with detention ponds which allows for groundwater recharge & maintains the existing drainage pattern as far as possible is desired. A network of open drains shall be designed & provided to carry surface run off. The drains shall be trapezoidal or rectangle section lined with concrete slabs/brick masonry/stone masonry/stone slabs. The minimum thickness of these lining shall be 115mm for brick masonry, 75mm thick for concrete slab, 150mm thick for stone masonry and 100mm thick for stone slab.</p> <p>Suitable size drain shall also be provided on either side of road for quick disposal of water from road and solar blocks. Provision of culverts and their design to be submitted separately. The road on the culvert portions of the drains shall be concrete road.</p> <p>Bidder shall also ensure that drainage from his plot does not encroach/flood in to the adjacent property and adjacent solar plots. Bidder shall try to maintain existing natural drain and shall remodel the natural drains in case of any disturbance made. The same shall be as per the technical/design requirements without affecting the drainage pattern. The bidder plot drainage scheme shall include to drain out the drainage of the allotted plot and shall include contributing catchment area consisting of adjoining plots and nearby catchment area.</p> <p>Bidder in its plot shall terminate its plot drains into the existing natural water body passing through its plot. The ‘additional drains’ scheme shall also be followed for the drainage system. Suitable strengthening of natural drain</p>			
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13.	SWITCHYARD CIVIL WORKS			
	<p>This part includes the technical requirements for 33 kV Switchyard/metering yard works (as indicated in SLD drawing 5714-004-POE-A-006 Rev A)including associated design and preparation of all civil & structural drawings and execution of all associated civil works. The specifications are intended for general description of work, quality and workmanship. The specifications are not however exhaustive to cover minute details and the work shall be executed according to relevant latest Indian Standards / IRC or IRS Specifications. This specification covers design, preparation of general arrangement drawings, construction and fabrication drawings, supply of materials and construction of all civil, structural and architectural works. The materials specification for the switchyard items shall be same as the material specification mentioned for CMCS building unless otherwise quoted specifically in this clause.</p>			
13.1	Design Criteria for Switchyard Works			
	General			
	<p>Structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, piping loads (static and dynamic), wind loads, seismic loads and temperature loads. In addition, loads and forces developed due to differential settlement shall also be considered.</p>			
13.2	Loading			
	Dead Loads			
	<p>Dead loads shall include the weight of structure complete with finishes, fixtures and partitions and shall be taken as per IS: 875 (Part - I).</p>			
	Imposed Loads			
	<p>Imposed loads in different areas shall include live, erection, operation and maintenance loads. Equipment loads (which constitute all loads of equipment to be supported on the building frame) are not included in the imposed loads furnished below and shall be considered in addition to imposed loads.</p>			
	<p>For consideration of imposed loads on structures, IS: 875 (Part – II) “Code of practice for design loads (other than earthquake) for buildings & structures” shall be followed.</p>			
	Equipment loads			
	<p>Loads of all equipment like Electrical control and relay panels, cable load, Pipe load (static and dynamic), Tanks, etc. shall be</p>			
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13.3	<p>considered over and above the imposed loads. Cable and piping loads not less than 5 kN/sq.m hanging from the underside, shall also be considered additionally for floors where these loads are expected.</p> <p>Seismic Load Seismic forces shall be considered in line with relevant IS codal provisions.</p> <p>Design Parameters for Gantry Towers & Beams, Lightning Mast and Equipment Supporting Structures:</p> <p>Gantry structure, which consists of open web towers connected by girders, shall be made of structural steel conforming to Grade IS:2062 and duly galvanized conforming to IS: 2629 and IS: 4759. All joints shall be bolted connections.</p> <p>The analysis of towers and gantries shall be carried out with combined model of critical configurations of towers and gantries using any established structural analysis software like STAAD Pro. etc.</p> <p>All bolts for connections shall be of minimum 12mm dia conforming to IS: 12427, property class 5.6 as per IS: 1367 (Part 3). Nuts shall conform to I.S 1363 (Part 3) of property class 5. Foundation bolts shall conform to IS: 5624, and property class shall be 4.6 as per IS: 1367 (Part 3).</p> <p>Butt splice shall be used for splicing the main members and splice shall be located away from the node point.</p> <p>IS: 802 “Code of practice for use of structural steel in overhead transmission line towers” shall be followed for design of structures. Height & type of towers shall be established based on electrical requirements. A provision of ± 30 degree angle of deviation of line in horizontal plane and ± 20 degree deviation in vertical plane is considered and the resulting worst combination of forces shall be considered for design. For all outgoing and incoming feeders, the conductor span shall be taken as 200m for design purpose.</p>			
	<p>Loads and Loading Conditions:</p> <p>Switchyard structures shall be designed for the worst combination following loads:</p> <p>1) Dead loads (load of wires/conductors, insulator, electrical equipment and structural members)</p> <p>2) live loads,</p>			
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14.	LIST OF APPLICABLE INDIAN STANDARDS:													
	Indian codes, and/or standards shall govern, in all the cases wherever they are available. In case of a conflict between such codes and/or standards and the specifications, the stringent provisions shall govern. Such codes and/or standard referred to shall mean the latest revision, amendments/changes adopted and published by the relevant agencies. In case of any further conflict in this matter the same shall be referred to the Engineer-in-charge, whose decision shall be final and binding.													
	Other internationally acceptable standards shall be accepted, only if, no Indian Standards are existing. However, other standards also will be accepted if the Contractor establishes that the works are meeting the requirements of Indian Standards also.													
	A brief list of Indian Standards applicable to these works is as below:													
	General													
	<table><tr><td>IS: 875-I</td><td>Code of Practice for Design Dead Loads for Building and Structures</td></tr><tr><td>IS: 875-II</td><td>Code of Practice for Design Imposed Loads for Building and Structures</td></tr><tr><td>IS: 875-III</td><td>Code of practice for design loads (other than earthquake) for buildings and structures.</td></tr><tr><td>IS: 1893</td><td>Criteria for earthquake resistant design of structures.</td></tr><tr><td>IS: 4326</td><td>Code of Practice for earthquake resistant design and construction of buildings</td></tr></table>				IS: 875-I	Code of Practice for Design Dead Loads for Building and Structures	IS: 875-II	Code of Practice for Design Imposed Loads for Building and Structures	IS: 875-III	Code of practice for design loads (other than earthquake) for buildings and structures.	IS: 1893	Criteria for earthquake resistant design of structures.	IS: 4326	Code of Practice for earthquake resistant design and construction of buildings
	IS: 875-I	Code of Practice for Design Dead Loads for Building and Structures												
	IS: 875-II	Code of Practice for Design Imposed Loads for Building and Structures												
	IS: 875-III	Code of practice for design loads (other than earthquake) for buildings and structures.												
	IS: 1893	Criteria for earthquake resistant design of structures.												
IS: 4326	Code of Practice for earthquake resistant design and construction of buildings													
Foundations														
<table><tr><td>IS: 1080</td><td>Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell)</td></tr><tr><td>IS: 1904</td><td>Code of practice for structural safety of building foundations</td></tr></table>				IS: 1080	Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell)	IS: 1904	Code of practice for structural safety of building foundations							
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CLAUSE NO.	<div style="text-align: right;">  </div> TECHNICAL SPECIFICATIONS		
	IS: 2950	Code of practice for design and construction of raft foundations.	
	IS: 4091	Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles	
	IS: 6403	Code of Practice for determination of bearing capacity of shallow foundations	
	IS: 8009	Code of Practice for foundation settlement calculations	
	IS: 2911	Design & Construction of Pile Foundation - Code of Practice	
	Concrete Structures		
	IS: 456	Code of practice for plain and Reinforced concrete	
	IS: 3370	Code of practice for concrete structures for the storage of liquids.	
	IS: 3414	Code of Practice for design and installation of joints in buildings	
	IS: 5525	Recommendation for detailing of reinforced concrete works	
	IS: 6313	Code of practice for anti-termite measures in buildings	
	IS: 13920	Ductile detailing of Reinforced Concrete Structures subjected to Seismic forces	
	IS: 1904	Code of practice for design and construction of foundations in soils general requirements	
	Steel Structures		
	IS: 800	Code of practice for use of structural steel in general building construction	
	IS: 801	Code of practice for use of cold-formed light gauge steel structure members	
	IS: 802	Code of Practice for use of Structural Steel in over Head Transmission Line Towers.	
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CLAUSE NO.	<div style="text-align: right;">  </div> TECHNICAL SPECIFICATIONS		
	IS: 806	Code of practice for use of steel tubes in general building construction.	
	IS: 808	Dimensions for hot rolled steel beam, column channel and angle section	
	IS: 811	Specification for Cold Formed Light Gauge Structural Steel Sections	
	IS: 813	Scheme of symbols for welding	
	IS: 1079	Hot Rolled carbon Steel Sheet and Strip - Specification	
	IS: 2062	Hot Rolled Medium and High Tensile Structural Steel - Specification	
	IS: 4923	Hollow steel sections for structural use.	
	IS 1161	Steel tubes for structural purpose	
	IS: 2721	Galvanised steel chain link fence fabric - Specification	
	Painting and Coating		
	IS: 4736	Hot-dip zinc coatings on mild steel tubes	
	IS: 4759	Hot-dip zinc coatings on structural steel and other allied products - Specification	
	IS:1868	Anodic coatings on aluminium and its alloys	
	IS 2395-I	Painting of Concrete, Masonry and Plaster Surfaces - Code of: Operations and Workmanship	
	IS 2395-II	Code of practice for painting concrete, masonry and plaster surfaces: Schedule	
	IS 1477-I	Code of Practice for Painting of Ferrous Metals in Buildings: Pre-treatment	
	IS:1477-II	Code of practice for painting of ferrous metals in buildings: Painting	
	Water supply and sanitary		
	IS: 1239	Mild steel tubes and tubulars and other wrought steel fittings	
	IS: 1172	Code of basic requirements for water supply, drainage and	
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CLAUSE NO.	<div style="float: right;">  </div> TECHNICAL SPECIFICATIONS	
		sanitation
	IS: 1742	Code of Practice for building drainage
	IS: 2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
	IS: 15778	Chlorinated polyvinyl chloride pipes for potable hot and cold water distribution supplies
	IS: 16088	Chlorinated polyvinyl chloride pipes for automatic sprinkler fire extinguishing system
	IS: 10124	Fabricated PVC fittings for potable water supplies
	IS: 4985	Un-plasticized PVC pipes for potable water supplies
	IS: 13592	Un-plasticized Polyvinyl Chloride (PVC-U) Pipes for Soil and Waste Discharge System Inside and Outside Buildings Including Ventilation and Rainwater System
	IS: 12818	Un-plasticized polyvinyl chloride (PVC-U) screen and casing pipes for bore/tubewell
	IS: 2470	Code of Practice for installation of septic tanks
	Miscellaneous	
	IS: 1905	Code of Practice for structural use of un-reinforced masonry
	IS: 3067	Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
	SP: 6	Handbook for structural engineers (all parts)
	SP: 7	National Building Code of India
	SP: 16	Design Aids for reinforced concrete to IS:456
	SP: 20	Handbook on masonry design and construction
	SP: 22	Explanatory handbook on codes for earthquake engineering
	SP: 24	Explanatory handbook on Indian Standard Code of Practice for plain and reinforced concrete
	SP: 25	Handbook on causes and prevention of cracks in buildings
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CLAUSE NO.	TECHNICAL SPECIFICATIONS		<div>एनटीपीसी NTPC</div>	
	SP: 32	Handbook on functional requirements of industrial buildings		
	SP: 34	Handbook of concrete reinforcement & detailing		
	IRC: 37	Guidelines for design of flexible pavements		
	IRC: 42	Guidelines on Road Drainage		
	IRC: 58	Guidelines for the design of rigid pavements for highways		
	IRC: 73	Geometric design of roads		
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CLAUSE NO.	<div>एनटीपीसी NTPC</div> <div>TECHNICAL SPECIFICATIONS</div>
	<div> <p>PART-E</p> <p>GENERAL SYSTEMS</p> </div>

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E-1) WEATHER MONITORING STATION

As a part of weather monitoring station, Bidder shall provide following measuring instruments with all necessary software & hardware required to integrate with SCADA so as to enable availability of data in SCADA.

1.0


PYRANOMETER

Bidder shall provide minimum two (02) number of pyranometers for measuring incident global solar radiation. One of them shall be placed on horizontal surface and the other on adjustable inclined plane. The specification for pyranometers shall be as follows:

Sl.No	Details	Values
1.	Spectral Response.	0.31 to 2.8 micron
2.	Sensitivity	Min 7 micro-volt/w/m ²
3.	Time response(95%):	Max 15 s
4.	Non linearity:	±0.5%
5.	Temperature Response:	±2%
6.	Tilt error:	< ±0.5%.
7.	Zero offset thermal radiation:	±7 w/m ²
8.	Zero offset temperature change	±2 w/m ²
9.	Operating temperature range:	0 deg to +80 deg.
10.	Uncertainty (95% confidence Level):	Hourly- Max-3%, Daily- Max-2%
11.	Non stability:	Max ±0.8%
12.	Resolution:	Min + / - 1 W/m ²
13.	Input Power for Instrument & Peripherals:	230 V a.c. (If required)

Each instrument shall be supplied with necessary cables. Calibration certificate with calibration traceability to World Radiation Reference (WRR) or World Radiation Centre (WRC) shall be furnished along with the equipment. The signal cable length shall not exceed 20m. Bidder shall provide Instrument manual in hard and soft form.

CLAUSE NO.	TECHNICAL SPECIFICATIONS									
2.0	<p>THERMOMETER</p> <p>Bidder shall provide minimum two thermometers (one for ambient temperature measurement with shielding case and other for module temperature measurement). The thermometers shall be RTD / semiconductor type measuring instrument. Instrument shall have a range of 0°C to 80°C. The instrument shall have valid calibration certificate.</p>									
3.0	<p>ANEMOMETER</p> <p>Bidder shall provide minimum one no. anemometer with wind vane of rotating cup type</p> <table><tr><th>Sl.No</th><th>Details</th><th>Values</th></tr><tr><td>1.</td><td>Velocity range with accuracy limit</td><td>± 0.11 m/s upto 10.1 m/s ± 1.1 % of true when more than 10.1 m/s</td></tr><tr><td>2.</td><td>Wind direction range with accuracy limit</td><td>0 to 360 deg with accuracy ± 4 deg</td></tr></table> <p>The instrument shall have valid calibration certificate.</p>	Sl.No	Details	Values	1.	Velocity range with accuracy limit	± 0.11 m/s upto 10.1 m/s ± 1.1 % of true when more than 10.1 m/s	2.	Wind direction range with accuracy limit	0 to 360 deg with accuracy ± 4 deg
Sl.No	Details	Values								
1.	Velocity range with accuracy limit	± 0.11 m/s upto 10.1 m/s ± 1.1 % of true when more than 10.1 m/s								
2.	Wind direction range with accuracy limit	0 to 360 deg with accuracy ± 4 deg								



CLAUSE NO.

TECHNICAL SPECIFICATIONS

E-2) FIRE FIGHTING AND ALARM SYSTEM

The SPV plant shall be equipped with suitable fire protection & firefighting systems for protection of entire equipment switchyard & control room as per CEIG requirements.

1.0 Bidder shall comply with recommendation of Tariff Advisory Committee to incurring minimal premium for insurance. The installation shall meet all applicable statutory requirements, safety regulations in terms of fire protection.

2.0 The firefighting system for the proposed power plant for fire protection shall be consisting of:

- a) Sand buckets
- b) Portable fire extinguishers
- c) Microprocessor based fire alarm panel.

2.1 Portable Fire Extinguishers and Sand Buckets

Bidder to provide following number of portable fire extinguishers in the rooms mentioned below.

Rooms	DCP Type (ABC type) (10 Kg. Capacity)	CO ₂ Type 9 kg capacity	Foam Type Hand 9 kg	Hand Portable pressurized water CO ₂ 9 Litre	Sand Buckets
Control Room	1	1	1	1	1
Each Inverter Room	1	1			1
ACDB Room(If applicable	1	1			
Each Transformer Yard	1	1			
Switchyard	2	2			
Security Room				2	
Pantry				2	


CLAUSE NO.	<div style="float: right;">एनटीपीसी NTPC</div> TECHNICAL SPECIFICATIONS
2.2	<p>Microprocessor based fire alarm panel</p> <p>Bidder to provide intelligent microprocessor based main fire alarm panel of modular construction complete with central processing unit, input and output modules, power supply module, supervision control and isolator modules with 10% spare provisions. Fire detection alarm system shall include) but not limited to the following items</p> <ol style="list-style-type: none"> 1. Fire Alarm control Panel 2. Multi Sensor smoke detector 3. Hooter cum strobe 4. Manual call Point 5. Hooter 6. Fault isolation modules 7. Control Modules 8. Cables from Sensors to Fire panels. 9. Digital output from the fire detection system shall be integrated with SCADA <p>Multi sensor type smoke detectors shall be provided for below false ceiling areas of control room and ACDB and/or inverter rooms. One (01) sensor shall be provided for each 25 sqm of area.</p> <p>Fire Alarm Control Panel Indication</p> <ol style="list-style-type: none"> i. Alarm conditions shall be immediately displayed on the control panel. Alarm LED shall flash on the control panel until the alarm has been acknowledged. Once acknowledged the LED shall remain lit. A subsequent alarm received from another zone after acknowledgement shall illuminate the alarm LED and the panel display shall show the new alarm information. ii. During an alarm condition, an alarm tone shall sound within the control panel until the alarm is acknowledged. iii. If the audible alarm signals are silenced for any reason, they shall automatically resound if another zone is activated. iv. All alarm signals shall be automatically “locked in” at the control panel until the operated device is returned to its normal condition and the control panel is manually reset


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	<p style="text-align: center;">E-3) MODULE WASHING SYSTEM</p> <ol style="list-style-type: none"> 1. Bidder shall provide permanent arrangement for module washing in the SPV Plant. This shall include installing deep bores well(s) with pump(s) and motor, requisite storage arrangement and laying network of HDPE pipe conforming to IS 4984 and other relevant codes. The module washing shall be complete in all respect and the details shall conform to the relevant IS codes. The complete scheme shall be subject to approval of the owner including inputs points, design and drawings for the system. Opening from the HDPE pipe with manual isolating valves should be provided at regular intervals. The opening pipes for fixing the movable/Hose pipes for spraying water on module shall be made of GI pipe. Bidder shall install flow meter for measurement of water consumption. 2. The water used for cleaning should be of appropriate quality fit for cleaning purpose as per the recommendations of module manufacturer. 3. Bidder shall provide the piping and the instrumentation diagram (P&ID) of water washing arrangement including the physical sequence of branches, reducers, valves, pressure gauge, cleaning points with location of pump(s) and water storage tanks to NTPC for approval during detailed engineering. 4. The HDPE pipe shall be suitably protected against any impact load. The HDPE pipes shall be covered higher diameter GI pipe at roads crossing for protection against any heavy loads etc. at roads section. The same protection shall also be provided wherever higher loads are expected. The bidder may also propose some other protection system for HDPE pipes. 5. These pipes shall be buried in ground by at least 150mm deep from NGL/FGL. Only in case of rock at surface and difficulty in cutting the surface rocks pipe may be accepted at surface at some location. The same shall be subject to approval from the owner.

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	<p style="text-align: center;">E-4) TRIAL RUN & OTHER GENERAL REQUIREMENTS</p> <p>1.0 TRIAL RUN</p> <p>SPV Plant site shall be deemed to be successfully erected & commissioned after submission of relevant commissioning certificate from NTPC</p> <p>During the trial operation, SPV plant shall perform trouble-free operation for cumulative 24 hours during which functionality of all plant components shall be demonstrated and the system shall be in Generating Mode.</p> <p>2.0 WARRANTY</p> <p>Warranty for Solar PV Module: Each Solar PV modules used in solar power plants/ systems must be warranted for their output peak watt capacity, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years from the date of successful completion of the trial run.</p> <p>Extended Equipment Warranty (other than solar PV Modules): The successful bidder shall provide a warranty covering mechanical structure, electrical works including PCU/ inverters/ maximum power point tracker transformers and overall workmanship of the solar power plants/ system against any manufacturing/ design/ installation defects for a period of five (5) years. The Extended Equipment Warranty period (other than solar PV Modules) shall also commence from the date of successful completion of trial run.</p> <p>3.0 INSURANCE</p> <p>The bidder's insurance liabilities pertaining to the scope of works are detailed out in Clauses titled Insurance in General Conditions of Contract. The bidders insurance liabilities during O&M period has been brought out in Chapter E-5.</p>

CLAUSE NO.	<div>  </div> TECHNICAL SPECIFICATIONS
4.0	<p>TAKING OVER</p> <p>Upon successful completion of all the facilities pertaining to the scope of work contractor shall approach the owner in writing for “final take over” of the plant. On receipt of such request, owner shall issue to the contractor a taking over certificate as a proof of the final acceptance of the system. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.</p>

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	<p style="text-align: center;">E-5) OPERATION AND MAINTENANCE</p> <p>1.0 The successful bidder shall provide Operation and maintenance of SPV Plant along with grid connecting system for a period of five (5) years from date of successful completion of trial run. During O&M period, NTPC personnel shall have unrestricted entry to the solar plant and Control Room any time. NTPC may suitably depute its personals to associate with O&M activities. Contractor shall assist them in developing expertise through their day to day O&M activities. All records of maintenance must be maintained by the contractor which can be accessed by NTPC on demand. These records are to be handed over to NTPC after the O&M period of contract.</p> <p>2.0 The bidder shall be responsible for supply of all spare parts, repairs / replacement of any defective equipment(s) at his own cost as required from time to time during the O&M period.</p> <p>3.0 The contractor shall be responsible for the Operation and Maintenance of the entire Solar PV plant during the O&M period. The brief scope of works is listed below. The details shall be further elaborated by the bidder in the O&M manual to be submitted to NTPC for approval.</p> <ul style="list-style-type: none"> (a) Ensuring successful operation of SPV Plant for optimum energy generation. (b) Ensuring Breakdown maintenance, Preventive maintenance overhauls, Arranging visit of O&M experts (when required) to maximize the availability of the solar plant. (c) Daily work of the operators involves logging the voltage, current, power factor, power and energy output of the SPV plant, temperature, logging down individual array output data once a day (d) The operator shall record monthly energy output of each array and transformer and reports shall be prepared on performance of SPV plant (e) Submission of periodical reports to the owner on the energy generation & operating conditions of the SPV plant. (f) Ensuring Safety and protection of the plant by deputing sufficient security personals

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	<ul style="list-style-type: none"> (g) Monitoring, controlling, troubleshooting, maintaining of records, registers. (h) Supply of all type of spares, consumables and fixing / application of the same. (i) Cleaning of the plant including array yard on regular basis and as and when required. (j) Cleaning of drains, cable trenches, box culverts etc (k) Module washing as per as per approved schedule. (l) Herbicide spray and grass cutting on a periodic basis (m) Module tilt angle changing as per the schedule approved during detailed engineering. (n) The contractor shall at his own expense provide all amenities to his workmen as per applicable laws and rules. (o) The Contractor shall ensure that all safety measures are taken at the site to avoid accidents to his employees or his Co-contractor's employees (p) The Contractor shall immediately report the accidents, if any, to the Engineer In charge & to all the concerned authorities as per prevailing laws of the state. (q) The Contractor shall comply with the provision of all relevant Acts of Central or State Governments including payment of Wages Act 1936, Minimum Wages Act 1948, Employer's Liability Act 1938, Workmen's Compensation Act 1923, Industrial Dispute Act 1947, Maturity Benefit Act 1961, Employees State Insurance Act 1948, Contract Labor (Regulations & Abolishment) Act 1970 or any modification thereof or any other law relating whereto and rules made there under from time to time. (r) In order to ensure longevity, safety of the core equipment and optimum performance of the system the contractor should use only genuine spares of high quality standards. (s) Deployment of Plant in Charge, adequate number of technical support staff and other supporting personnel during the O&M period (t) Bidder is required to maintain adequate O&M spare during the O&M contract period of the Solar PV plant with the view to maximize availability of the plant. In case, Contractor uses mandatory spares, provided by NTPC, the contractor shall have to return/replenish the spare(s) of the matching quality, quantity and rating within shortest possible time. (u) At the time handing over of the plant by the contractor to NTPC, the contractor shall handover equipment and spares in healthy condition.

CLAUSE NO.	TECHNICAL SPECIFICATIONS
4.0	(v) Contractor shall be responsible to carry out all test and work as required by statutory regulation in effect as on date of Techno-commercial bid opening during O&M period.
	Insurance
	(a) NTPC shall take Fire & Allied Peril insurance during O&M period. Insurance for theft to be taken by contractor.
	(b) 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, disability 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 liabilities shall not be less than the following:
	Workmen's Compensation - As per Statutory Provisions
	Employee's Liability - As per Statutory Provisions
	(c) 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:
	Fatal Injury person : Rs.100,000 each
	occurrence : Rs.200,000 each
	Property Damage occurrence : Rs.100,000 each

5.0

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).

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.

(a) The Contractor shall maintain quarterly plant availability factor of 99% during the O&M period. The methodology of calculating the plant availability factor is as per Annexure-A.

- (b) For any shortfall in the quarterly plant availability factor w.r.t. the above target value, LD will be levied as shown below:

SLNO	Plant Availability Factor	LD Applicable for each year (in lakhs)
1	99% & above	NIL
2	Below 99 %	Rs. 3,840.00 /MW/Quarter for each 1% fall in Availability Factor. LD shall be pro-rata basis in case shortfall of LD comes to be decimal value.

- (c) The maximum value of LD shall be limited to Rs 1.536 lakh/MW per year**


6.0

Handing over of the Plant

- (a) At the end of the contract period, the contractor shall hand over the plant and equipment back to the owner in completely safe and healthy condition and without any pending defect.

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7.0	<div> <div>(b)</div> <div>The items supplied by NTPC on returnable basis, such as spares parts (from mandatory spares or through procurement)), consumables, tools and plants, documents etc. shall be returned back to NTPC. Else suitable recoveries shall be made from the Contractor's bills.</div> </div> <div> <div>After O&M period, NTPC may at its discretion decide to extend the existing O&M contract on mutually acceptable terms & conditions or undertake the O&M of the SPV Plant on its own.</div> <div> <div>Calculation of Plant Availability Factor:</div> <div> <div>A.</div> <div> <div>Correction Factor for annual degradation (1% every year): (X)</div> <div>Table-A</div> <table> <tr> <td>1st year</td> <td>2nd year</td> <td>3rd year</td> <td>4th</td> <td>5th</td> </tr> <tr> <td>1.0</td> <td>0.99</td> <td>0.98</td> <td>0.97</td> <td>0.96</td> </tr> </table> </div> </div> <div> <div>B.</div> <div> <div>Correction Factor for monthly generation variance : (Y)</div> <div>Table-B</div> <table> <tr> <td>Month</td> <td>CUF Correction Factor</td> <td>Basis of correction factor*</td> </tr> <tr><td>January</td><td>1.06</td><td>20.21/19.11</td></tr> <tr><td>February</td><td>1.02</td><td>19.59/19.11</td></tr> <tr><td>March</td><td>1.12</td><td>21.31/19.11</td></tr> <tr><td>April</td><td>1.06</td><td>20.31/19.11</td></tr> <tr><td>May</td><td>1.09</td><td>20.80/19.11</td></tr> <tr><td>June</td><td>0.96</td><td>18.43/19.11</td></tr> <tr><td>July</td><td>0.77</td><td>14.65/19.11</td></tr> <tr><td>August</td><td>0.75</td><td>14.27/19.11</td></tr> <tr><td>September</td><td>0.87</td><td>16.70/19.11</td></tr> <tr><td>October</td><td>1.07</td><td>20.43/19.11</td></tr> <tr><td>November</td><td>1.00</td><td>19.14/19.11</td></tr> <tr><td>December</td><td>1.01</td><td>19.25/19.11</td></tr> </table> </div> </div> <div> <div>*- Monthly CUF / Annual CUF, based on guaranteed monthly & annual generation figures quoted in EPC contract.</div> </div> </div> </div>	1 st year	2 nd year	3 rd year	4 th	5 th	1.0	0.99	0.98	0.97	0.96	Month	CUF Correction Factor	Basis of correction factor*	January	1.06	20.21/19.11	February	1.02	19.59/19.11	March	1.12	21.31/19.11	April	1.06	20.31/19.11	May	1.09	20.80/19.11	June	0.96	18.43/19.11	July	0.77	14.65/19.11	August	0.75	14.27/19.11	September	0.87	16.70/19.11	October	1.07	20.43/19.11	November	1.00	19.14/19.11	December	1.01	19.25/19.11
1 st year	2 nd year	3 rd year	4 th	5 th																																														
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CLAUSE NO.	TECHNICAL SPECIFICATIONS																					
C.	<div>Correction Factor for Full / Partial loading due to Full / Partial Equipment outage (Table-C)</div> <div>Table-C</div> <table><tr><th>Sl. No.</th><th>Equipment</th><th>Correction Factor</th></tr><tr><td></td><td>E</td><td>W</td></tr><tr><td>1</td><td>total plant shut down, other than grid outages</td><td>1.0</td></tr><tr><td>2</td><td>Transformer/associated HT panels/Associated HT cables</td><td>1 / Total number of transformers</td></tr><tr><td>3</td><td>Inverters/associated Switchgear or cable</td><td>1 /Total number of inverters</td></tr><tr><td>4</td><td>String Monitoring Unit *</td><td>1 / Total number of SMU's</td></tr><tr><td>5</td><td>PV strings *</td><td>1/ Total number of PV Strings</td></tr></table> <div>*In case of outage of DC cable connecting to inverter, all strings connected to SMU shall be treated to be out.</div> <div>Table-D</div> <div><div>a) Monthly corrected non-Availability hours (A)</div><div>$: E_i \times W_i \times \left\{ \begin{array}{c} \text{Correction Factor} \\ \text{For degradation} \\ \mathbf{X} \end{array} \right\} \times \left\{ \begin{array}{c} \text{Correction factor} \\ \text{for monthly} \\ \text{generation} \\ \text{Variance} \\ \mathbf{Y} \end{array} \right\}$</div></div> <div>Where E_i = the number of hours of generation loss due to non availability of equipment during solar hours for the equipment E_i (Refer Table –C above)</div> <div>W_i = Weightage factor for Equipment E_i (Refer Table-C above)</div>	Sl. No.	Equipment	Correction Factor		E	W	1	total plant shut down, other than grid outages	1.0	2	Transformer/associated HT panels/Associated HT cables	1 / Total number of transformers	3	Inverters/associated Switchgear or cable	1 /Total number of inverters	4	String Monitoring Unit *	1 / Total number of SMU's	5	PV strings *	1/ Total number of PV Strings
	Sl. No.	Equipment	Correction Factor																			
		E	W																			
	1	total plant shut down, other than grid outages	1.0																			
	2	Transformer/associated HT panels/Associated HT cables	1 / Total number of transformers																			
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	4	String Monitoring Unit *	1 / Total number of SMU's																			
	5	PV strings *	1/ Total number of PV Strings																			

CLAUSE NO.	<div style="text-align: right;">  </div> TECHNICAL SPECIFICATIONS
	<p>Table-E</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p>b) Quarterly Plant non availability factor(%) = $\left\{ \frac{\text{Quarterly corrected Non availability Hours} \times 100}{1095} \right\}$</p> <p style="text-align: center;">---</p> </div> <p>Table-F</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p>b) Quarterly plant availability factor (%) : 100 – Quarterly plant non-availability factor(%)</p> </div> <p>Notes:</p> <ol style="list-style-type: none"> 1) For the calculation of Quarterly plant availability factor, 12 hours per day shall be considered as the solar time. Quarterly solar hours : 1095. 2) The Quarterly plant availability factor shall be rounded off to 2 decimal place. 3) The plant outage periods due to grid related problems (grid outage, grid restrictions, grid fluctuations, evacuation system problems like external 132kV feeder breakdown etc.) and due to natural causes like, earth quake, cyclone, flood etc. And other such force majeure related events shall be excluded while calculating the plant availability factor. 4) The equipment outage, not affecting the generation, will not be considered while calculating the plant availability factor.

Example:

Suppose, the non-availability of the equipments (during the solar hours) during 3rd year of contract for the month of June for a plant capacity is as below.

Switchyard (Total plant shut down):.	10 Hrs
Transformer and HT Panel :	180 Hours
String Monitoring Unit:	800 Hrs
Inverter and associated Switchgear:	99 hrs.

Assumptions: Total No of SMU: 520; Total No of Inverter Transformer: 33; Total No of Inverters:66;
The total non-availability for the month of June (3rd year):Refer Table – C above

$$10 \times 1 + 180 \times (1/33) + 800 \times (1/520) + 99 \times (1/66) = 10 + 5.45 + 1.54 + 1.5 = 18.49 \text{ Hrs.}$$

Corrected Non Availability for the month of June of 3rd year:

$$18.49 \times 0.98^* \times 0.96 = 17.40 \text{ Hrs. -----(A)}$$


*-Correction Factor for annual degradation (Refer Table-A)

**- Correction Factor for monthly irradiation (Refer Table-B)

Suppose the monthly corrected non availability hours (calculated as per example at A above) for the 3rd year are as below: (Table-G)

Month	Corrected non-availability hours
January	12.41
February	15.64
March	16.56
April	17.43
May	10.91
June	17.40
July	9.13
August	14.65
September	21.45
October	8.47
November	13.21
December	12.17
Total	170.69

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	<div>Then,</div> <div><div>Quarterly non availability hours (April to June) 17.43+10.91+17.40=45.74 (Refer Table-G)</div><div>Quarterly(April to June) non availability factor (%): 45.74 X 100 / 1095= 4.18% (Refer Table – E)</div><div>The Quarterly availability factor (%) : 100 – 4.18 % = 95.82% (Refer Table-F)</div></div> <div>Shortfall in availability factor=99-95.82=3.18%</div> <div>Applicable Quarterly LD=50x3.18x3840= Rs. 6.10 Lakhs</div>

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	<p style="text-align: center;">E-6) PERFORMANCE GUARANTEE (PG) TEST</p> <p>The final acceptance test as to prove the Performance Guarantee shall be conducted at Site by the Contractor in presence of the Employer. The PG test procedure shall be submitted by the contractor to the NTPC for approval. This test shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.</p> <p>The procedure for PG demonstration test shall be as follow:</p> <ol style="list-style-type: none"> 1. In addition to the two pyranometers to be supplied under the scope of work, the contractor shall install one more calibrated pyranometers at horizontal plane at locations mutually agreed by Contractor and NTPC. The additional pyranometer shall be free of cost on returnable basis. 2. Contractor shall also install data logger to store all the pyranometers data during test period. A valid test reports for the installed pyranometers shall be submitted by the Contractor for approval to NTPC. The output of both pyranometers mounted on horizontal plane shall be made available at SCADA during the complete PG test duration i.e. three month period. During the PG test period, the module tilt shall be kept as per approved schedule. 3. Actual energy exported from the plant shall be noted for three consecutive month period. For this purpose, the net energy exported at 33kV outgoing feeder and pyranometers reading shall be noted at agreed frequency on daily basis for entire PG test period. 4. This measured value of energy(actual energy exported) at step-3 shall be compared with “Target Generation” for the PG test. 5. “Target Generation” for the month and corresponding Global horizontal insolation of the site for 50 MW is given below.

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Month	GHI kWhr/(m ² xmonth)	Target Generation (kWhr)
January	140.6	7518500
February	153.9	7286545
March	202.4	7926512
April	212.4	7555357
May	223.2	7736686
June	192.2	6856299
July	147.3	5451636
August	141.4	5308012
September	162.7	6214182
October	174.1	7598570
November	141.8	7121028
December	133.2	7162007
Total Yearly Generation		83735334


6. The value of the target generation and corresponding Global Horizontal Insolation shall be on pro-rata basis in case the PG test does not start from the first day of the month.

7. Any special equipment, instrumentation tools and tackles and manpower, required for the successful completion of the Performance Guarantee Test shall be provided by the Contractor free of cost. The accuracy class of the instrumentation shall be as per the relevant clause of documents.

8. Following factors shall be considered for computing the “target Generation” and shortfall(if any)

9. Effect of any meteorological parameters shall not be considered except of solar radiation.

10. Variation of PG on account of Generation loss due to grid outage (or power evacuation system which is not in the scope of the Bidder): The measured global solar radiation of the period of the outage of the power evacuation system shall be excluded to calculate the cumulative global Insolation for the month. Under such situation, the radiation corresponding to the warm-up time of inverter as per data sheet shall also be adjusted to arrive at the cumulative global insolation for the month.

CLAUSE NO.	<div style="text-align: right;">  </div> TECHNICAL SPECIFICATIONS
	<p>11. If the difference of reading between the two horizontally mounted pyranometers exceeds more than 2%, the test shall be halted and resumed only after rectification of errors which has led to mismatch. The data of that particular day(s) shall be discarded and test period shall be extended by same numbers of day(s).</p> <p>12. The test shall be repeated in case of outage of following equipments for more than 7 days.</p> <ol style="list-style-type: none"> I. Converter transformer II. Power Conditioning Unit III. SCADA and data logger combined IV. Both pyranometers. <p>Further, if the plant is not able to achieve the target generation as per the PG procedure during the test period, then contractor shall compensate NTPC with an amount equivalent to the loss of generation based on sample calculation @ Rs. 55.22 per kWhr shortfall.</p> <p>Shortfall LD will be levied @ Rs 55.22 per kWhr shortfall.</p> <p>LD limit for Performance shortfall in PG shall be 10% of the contract price</p> <p>A sample calculation for shortfall in energy generation for period from 10th January to 09th April LD calculation for the site is given in next page. Any consecutive three months period for the purpose of conducting performance guarantee test shall be mutually discussed and agreed between NTPC and the bidder.</p>

DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH	TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-E	Page 304 of 415
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A sample calculation for 50 MW Total Short fall in Energy for Design life

Month	Global Solar Insolation of the month (kWhr/(m ² xday) (Data provided by NTPC) (a)	Target Generation (MWhr) (Data provided by NTPC) (b)	No of test days of the month (c)	Reference Solar Insolation (d) (a) x (c) / (N _{dm})	Modified Target Generation of the month MWhr (e)	Measured Global Horizontal Solar Insolation (kWhr/m ²) (f)	Corrected Target Generation (MWhr) (g)= (e) x (f)/(d)	Measured Generation at 33 kV transformer feeder (MWhr) (h)	Shortfall in energy for PG test (g-h)#
January	140.6	7518.500	22**	99.8	5336.745	97	5187.016	5162.802	24.214
February	153.9	7286.545	28	153.9	7286.545	165	7812.085	7762.8	49.285
March	202.4	7926.512	31	202.4	7926.512	208	8145.823	8185.804	-39.981
April	212.4	7555.357	9	63.7	2265.896	60	2134.282	2067.8	66.482

* N_{dm}= Nos of days in the month

** Test is assumed to start from 10 January till 9th April

-ve value denotes excess generation

Total Short fall in Energy for the test period(ΔG_{TP}) : 24.214+49.285 - 39.981+66.482=100.000 MWhr

Target generation for the test period (G_{TP}) : **22815.7** MWhr

Target yearly generation(G_Y) : **83735.334** MWhr

Yearly shortfall in generation(ΔG_Y) : $G_Y \times \Delta G_{TP} / G_{TP}$
: **83735.334 x 100/22815.7= 367.008 MWhr**

LD for per unit shortfall in generation= N x R=7.84313x7.04= **55.22/kWhr**


N= Present Worth Factor taking discount factor of 12% for 25 Years : 7.84313


R=CERC notified tariff for FY 2015-16 i.e. Rs. 7.04 /kWhr


Yearly loss of Revenue and applicable LD : $\Delta G_Y \times 1000 \times R \times N$
: **367.008 x 1000x55.22=202.66 Lakhs**

PART-F

QUALITY ASSURANCE CHAPTERS

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	QA CHAPTERs			
	LIST OF CONTENTS			
	</			

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	<div><div></div><div></div><div>17)Power Supply for C&I System(UPS/Battery/ Battery Charger/ACDB/DCDB) 18)Aux Dry Type Transformer 19)Oil Filled Transformer 20)Switchyard 21)Fire Extinguisher 22)Energy Meter 23)Module cleaning System and Ventilation 24)CCTV</div></div>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9	PART-F	Page 308 of 415


CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	<u>SPV module</u>			
	SPV modules quality plan should include the following: A) Incoming Checks on bought out items (listed in third party test reports of relevant standard), as per internal standards of the manufacturer B) In-process checks, as per internal standards of the manufacturer C) Sample tests as per following: 1) SPV modules to be checked visually for following defects: (sampling as per General Inspection Level II and AQL 1.5% as per IS 2500 Part 1) a) Scratches on the frame and/or glass b) Excessive or uneven glue marks on glass or frame c) Inconsistent cell colors d) Completeness of module in all respects 2) Performance of SPV module at STC (sampling as per General Inspection Level II and AQL 1.5% as per IS 2500 Part 1) 3) IR-HV-IR test (sampling as per Special Inspection Level S-2 and AQL 1.5% as per IS 2500 Part 1) 4) Robustness of terminations on 1 sample per offered lot 5) Mechanical load test on 1 sample per offered lot			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9		PART-F
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			<div>एनटीपीसी NTPC</div>
	<div><h3><u>Array Junction Box</u></h3><p>Array Junction quality plan should include the following:</p><div><div>A) Checks on bought out items as per internal standards of the manufacturer</div><div>B) In-process checks, as per internal standards of the manufacturer</div><div>C) Sample tests as per following:<div><div>1) IR-HV-IR test (sampling as per General Inspection Level-II and AQL 1.5% as per IS 2500 Part 1)</div><div>2) String Monitoring Card/ Power Supply card/ DC-DC Converter function check (sampling as per General Inspection Level-II and AQL 1.5% as per IS 2500 Part 1)</div><div>3) Communication Function Test (sampling as per General Inspection Level-II and AQL 1.5% as per IS 2500 Part 1)</div></div></div></div></div>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9	PART-F	Page 310 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS			<div>एनटीपीसी NTPC</div>
	<div>PCU</div>			
	<div>A) Checks on bought out items as per internal standards of the manufacturer</div> <div>B) In-process checks, as per internal standards of the manufacturer</div> <div>C) Routine tests as per following on the assembled PCU:</div> <div><div>1) Test to demonstrate automatic / manual synchronization and connection to utility service</div><div>2) Test to demonstrate operation protective (including utility service interface protection) and instrumentation circuits demonstrated by direct test if feasible or by simulation operation conditions for all parameters that cannot be directly tested.</div><div>3) Test to demonstrate operation of start-up, stable operation of the PCU,disconnection and shutdown controls and response to other control signals</div></div> <div>D) Following sample tests on the assembled PCU(1 Panel per offered lot):</div> <div><div>1. Sample testing to include measurement of phase currents, efficiencies, harmonic content and power factor at four points preferably 25, 50, 75 and 100% of the rated nominal power.</div><div>2. Maximum power point tracking (MPPT) functional check</div></div>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9	PART-F	Page 311 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS														<div>एनटीपीसी NTPC</div>																																																																																																																																																																																																																																																	
	<div>LT SWITCHGEAR SQE _10</div> <div>LT SWITCHGEAR (MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)</div> <table><tr><th>ATTRIBUTES / CHARACTERIS-TICS</th><th rowspan="2">Make, Model, Type, Rating & TC</th><th rowspan="2">Dimensions & Finish</th><th rowspan="2">Electrical properties</th><th rowspan="2">Mechanical Properties</th><th rowspan="2">Chemical properties</th><th rowspan="2">Functional & Operational Features as per NTPC Spec.</th><th rowspan="2">Item to conform to relevant</th><th rowspan="2">Pretreatment as per IS 6005</th><th rowspan="2">Paint Shade, Adhesion,</th><th rowspan="2">Functional Checks</th><th rowspan="2">Milli-volt drop Test</th><th rowspan="2">IR – HV – IR Test</th><th rowspan="2">Degree of Protection Routine</th><th rowspan="2">All Routine tests as per NTPC</th></tr><tr><th>ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLY</th></tr><tr><td>Sheet Steel (IS : 513)</td><td>Y</td><td>Y</td><td></td><td>Y</td><td>Y</td><td></td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Aluminum Bus bar Material (IS : 5082)</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td></td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Copper Bus bar Material (IS : 613)</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td></td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Support Insulator</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Air Circuit Breaker (IS: 13947)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td>Y</td></tr><tr><td>Energy Meters (IS : 13010, 13779)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td>Y</td></tr><tr><td>Power & Aux. Contactors (IS : 13947)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td></td></tr><tr><td>Protection & Aux. Relays (IS : 3231) (IEC 60255 / IEC 61850)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td>Y</td></tr><tr><td>Control & Selector Switches (IS : 13947)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td></td></tr><tr><td>CT's & PT's (IS 2705 / 3156)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Y</td></tr><tr><td>MCCB (IS : 13947)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td>Y</td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td></td></tr><tr><td>Indicating Meters (IS : 1248)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td>Y</td></tr><tr><td>Indicating Lamps (IS : 13947)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td></td></tr><tr><td>Air Break Switches (IS : 13947)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td>Y</td><td></td><td></td><td></td><td></td></tr><tr><td>Control Terminal Blocks</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>															ATTRIBUTES / CHARACTERIS-TICS	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per NTPC Spec.	Item to conform to relevant	Pretreatment as per IS 6005	Paint Shade, Adhesion,	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine	All Routine tests as per NTPC	ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLY	Sheet Steel (IS : 513)	Y	Y		Y	Y		Y								Aluminum Bus bar Material (IS : 5082)	Y	Y	Y	Y	Y		Y								Copper Bus bar Material (IS : 613)	Y	Y	Y	Y	Y		Y								Support Insulator	Y	Y	Y	Y			Y								Air Circuit Breaker (IS: 13947)	Y	Y				Y	Y			Y	Y			Y	Energy Meters (IS : 13010, 13779)	Y	Y				Y	Y			Y				Y	Power & Aux. Contactors (IS : 13947)	Y	Y				Y	Y			Y					Protection & Aux. Relays (IS : 3231) (IEC 60255 / IEC 61850)	Y	Y				Y	Y			Y				Y	Control & Selector Switches (IS : 13947)	Y	Y				Y	Y			Y					CT's & PT's (IS 2705 / 3156)	Y	Y					Y							Y	MCCB (IS : 13947)	Y	Y					Y			Y					Indicating Meters (IS : 1248)	Y	Y				Y	Y			Y				Y	Indicating Lamps (IS : 13947)	Y	Y				Y	Y			Y					Air Break Switches (IS : 13947)	Y	Y				Y	Y			Y					Control Terminal Blocks	Y	Y				Y	Y							
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DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH					TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9					PART-F		Page 312 of 415																																																																																																																																																																																																																																																				

CLAUSE NO.	TECHNICAL SPECIFICATIONS														
	LT SWITCHGEAR (MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)														
	ATTRIBUTES / CHARACTERISTICS ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLY	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per NTPC Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per NTPC spec	All Routine tests as per NTPC spec. & IS
	Fuse (IS 13703)	Y	Y				Y	Y							
	Control Transformer (IS : 12021)	Y	Y				Y	Y			Y				Y
	Push Buttons (IS : 4794)	Y	Y				Y	Y			Y				
	Transducer (IEC : 60688)	Y	Y				Y	Y			Y				Y
	MCB (IS : 8828)	Y	Y				Y	Y			Y				
	Breaker Handling Trolley	Y	Y				Y			Y	Y				Y
	Synthetic Rubber Gasket (IS : 11149)	Y	Y		Y	Y		Y							
	LT SWITCHGEAR (IS : 8623)	Y	Y				Y	Y	Y	Y	Y		Y	Y	Y
	Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Makes of all major Bought Out Items will be subject to NTPC approval.														
	DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH					TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9					PART-F		Page 313 of 415		

CLAUSE NO.	TECHNICAL SPECIFICATIONS															
	LT BUSDUCT															
	ATTRIBUTES , CHARACTERISTICS → ↓ ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimension & Surface Finish	Make, Type, Rating & TC	Electrical Properties	Mechanical Properties	Chemical Properties	Item to conform to relevant IS	WPS Approval, Welder Qualification	Weld Quality Check (DP test & x-ray Test)	Paint Shade, Thickness, Adhesion & Finish	Tightness by Torque measurement	Electrical Clearances	Galvanizing Test as per IS 2629/ 2633/ 4759	IR – HV – IR Test	Phase Sequence Check	Degree of Protection routine test as per NTPC spec.
	Aluminum Sheets / Plates / Strips / Flexibles / tubes (IS : 5082 / 737)	Y	Y		Y	Y	Y	Y	Y							
	CRCA Flats / ISMC (IS 2062)	Y	Y		Y	Y	Y									
	Neoprene / Synthetic Rubber Gaskets (IS 11149 / 3400)	Y	Y		Y	Y										
	Rubber Bellows (IS : 3400)	Y	Y		Y	Y										
	Support Insulator (BS : 2782, IEC : 660, IS : 10912)	Y	Y	Y	Y											
	Galvanized Structure & GI Earthing Flat (IS : 2629 / 2633 / 4749)	Y	Y				Y						Y			
	Space Heater & Thermostat		Y	Y										Y		
	LT Busduct (IS : 8623 PART 2)	Y	Y				Y	Y	Y	Y	Y	Y		Y	Y	Y
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Makes of all major Bought Out Items will be subject to NTPC approval.																
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH				TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9				PART-F				Page 314 of 415				

HT SWITCHGEAR

[illegible]

CABLING, EARTHING, LIGHTNING PROTECTION


CONTROL CABLES

QUALITY ASSURANCE & INSPECTION MODULE NO. SQE-16


CABLING, EARTHING, LIGHTNING PROTECTION


ITEMS/COMPONENTS / SUB SYSTEMS	ATTRIBUTES / CHARACTERISTICS													
	Dimension	Paint shade, paint thickness, adhesion	Pre-treatment of sheet	IP protection	Proof load*	Surface finish	Deflection test*	HV & IR	Galvanise Test (If Applicable)	Functional	Bought out items/Bill of material	Routine tests as per relevant standard & specification	Acceptance tests as per relevant standard & specification	Constructional feature as per NTPC Specification
Wall Mounted-Lighting Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y		Y	Y	Y	Y	Y
Switch box/junction box/ Receptacles Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y
Cable glands (BS-6121)	Y													Y
Cable lug	Y													Y
Lighting wire (IS-694)	Y											Y		
Flexible conduits	Y											Y		Y
Conduits (Galvanise & Epoxy) IS-9537 & IS-2629, 2633, 6745	Y		Y						Y			Y		Y
RCC Hum Pipe (IS-458)												Y		
Cable termination & straight through joint (VDE-0278)	Y											Y		Y
Cable Trays, bends, tees, crosses, Flexible supports system & accessories IS-513, 2629,2633,6745	Y		Y		Y	Y	Y		Y			Y	Y	Y
Trefoil clamp	Y													Y
GI flats for earthing & lighting protection (IS 2062, 2629, 6745,2633)	Y		Y						Y			Y		Y
GI wire (IS-280)	Y											Y		
Fire Sealing System (BS –476)												Y	Y	Y


.Note:1. This is an indicative list of tests /checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2.* Deflection Test on cable trays and Proof Load test on cable trays support system will be as per details given in the NTPC technical specification & approved MQP. The above acceptance tests shall be done only on one sample from each size of offered lot. This test is not applicable on bends, tees & crosses.
3. Make of all items will be subject to NTPC approval.


CLAUSE NO.		TECHNICAL SPECIFICATIONS																
	<div>Attributes / Characteristics</div> <div>Item / Component s / Sub System Assembly</div>	Make, Type & T.C as per relevant standard	Dimension/surface finish	Mechanical properties	Chemical Composition	Spark Test(as applicable)	Electrical properties	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two wires	Sequential marking/ Batch marking/ surface finish/ cable length	T.S & elongation before & after ageing on outer sheath & insulation	Thermal stability	Anti termite coating on wooden drums	Constructional requirements feature as per NTPC specification	Routine & Acceptance Tests as per relevant standard & NTPC specification	FRLS Tests		
		Copper (IS-8130)	Y	Y	Y	Y		Y										
		PVC insulation Compound (IS: 5831)	Y		Y			Y				Y	Y					
		FRLS PVC Compound (IS-5831, ASTM-D2843, IS10810(Part 58), IEC-60754 Part-1)	Y		Y							Y	Y				Y	
		Extrusion & curing /Manufacturing of Core		Y			Y						Y					
		Core Laying							Y									
		Armour wire/strip	Y	Y	Y													
		Inner sheath	Y	Y														
		Armouring		Y						Y								
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH					TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9					PART-F			Page 317 of 415					


CLAUSE NO.	TECHNICAL SPECIFICATIONS															<div>एनटीपीसी NTPC</div>
	Outer Sheathing		Y							Y						
	Finished Cable (IS-5831, ASTM-D2843, IS10810(Part 58), IEC-60754 Part-1, IEC 60332 part III cat B)							Y	Y	Y	Y	Y		Y	Y	
	Wooden drum(IS-10418) /Steel Drum		Y										Y	Y		
	<div>Notes:</div> <div>1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.</div> <div>2. Make of all major Bought out items will be subject to NTPC approval.</div>															
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9									PART-F			Page 318 of 415		


CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	ROUTINE TESTS		Following routine tests shall be carried out on each drum of finished cables for all sizes.	
	1)	Conductor Resistance test		
	2)	High voltage test		
	ACCEPTANCE TESTS		Following Acceptance tests shall be carried out on each size of cables, in the offered lot.	
	A) For Conductor (as per sampling plan mentioned in IS: 1554)			
		1)	Annealing test (Copper)	
		2)	Resistance test	
	B) For Armour Wires / Formed Wires (If applicable) (as per sampling plan mentioned in IS: 1554)			
		1.	Measurement of Dimensions	
		2.	Tensile Tests	
		3.	Elongation Test	
		4.	Torsion Test	For Round wires only
		5.	Wrapping Test	
		6.	Resistance Test	
		7.	Mass of Zinc coating test	For G S wires / Formed wires only
		8.	Uniformity of Zinc coating	For G S wires / Formed wires only
		9.	Adhesion test	For G S wires / Formed wires only
		10.	Freedom from surface defects	
	C) For PVC insulation & PVC Sheath (as per sampling plan mentioned in IS: 1554)			
		1)	Test for thickness	
		2)	Tensile strength & Elongation before ageing (for tests after ageing see “D”)	
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9		PART-F
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CLAUSE NO.	TECHNICAL SPECIFICATIONS				
	D) Ageing test:				
		Criteria	Condition	Test Requirements	Remarks
	PVC insulation & outer sheath:	Samples as per relevant IS, from each size of cables in the offered lot, shall be tested for tensile strength & elongation (before ageing). Tensile & elongation testing shall preferably be done with a computerized machine. The values will be compared with corresponding values mentioned in the Type Test report accepted by NTPC. These values of Tensile Strength & Elongation (before ageing) should be within +/- 15% of the corresponding values of Type Test report. (Please note that test values should be more than the minimum values indicated in relevant standard).	All sizes which meet the criteria	The size which has maximum negative deviation from type test report values will be put on accelerated ageing test. The samples shall be aged in air oven at temperature of 130°C+/- 2°C for 5 hours and tested for TS & elongation. Acceptance norms shall be as per IS.	In case the size does not meet the requirement in accelerated ageing test then all sizes (which had met the criteria) will be put on ageing test as per IS.
			Sizes which do not meet the criteria	Every size will be put on ageing test as per IS.	----
	E) Following tests will be carried out on completed cables as per IS on each size:				
		1)	Insulation resistance test (Volume resistivity method)		
		2)	High voltage test		
	F) Following tests shall be carried out on only one size of offered lot (comprising of all sizes):				
		1)	Thermal stability test on PVC insulation and outer sheath		
		2)	Oxygen index test on outer sheath		
		3)	Smoke density rating test on outer sheath		
		4)	Acid gas generation test on outer sheath		
	G) Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cable will be carried out as per following sampling plan:				
			This test will be carried out using composite sampling i.e. irrespective of size; cables of one particular type (i.e. armoured, unarmoured) will be bunched together, as per calculations in line with the IEC. All sizes of armoured & unarmoured cables shall be covered.		
H) Following tests shall be carried on one length of each size (armoured & unarmoured) of offered lot:					
	1)	Constructional / dimensional check, surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Sequential marking, drum / outer sheath extrusion's batch number marking			
	2)	Measurement of Eccentricity & Ovality			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9		PART-F	Page 320 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS																		
	MV (3.3 kV / 6.6. kV / 11 kV / 33 kV) Cables																		
	Attributes / Characteristics	Make, Type & T.C as per relevant standard	Dimension/surface finish	Mechanical properties	Chemical Composition	Spark Test(as applicable)	Electrical properties	Hot Set Test/ Eccentricity & Ovality	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two wires	Sequential marking/ Batch marking/ surface finish/ cable length	T.S & elongation before & after going on outer sheath & insulation	Thermal stability on outer sheath	Metallic (Cu) Screening If applicable)	Anti termite coating on wooden drums	Constructional requirements feature as per NTPC specification	Routine & Acceptance Test as per relevant standard & NTPC specification	FRLS Test	
	Item / Components / Sub System Assembly																		
	Aluminum (IS-8130)	Y	Y	Y	Y		Y												
	Semiconducting Compound	Y		Y			Y												
	XLPE Compound (IS-7098 Part-II)	Y		Y			Y					Y							
	FRLS PVC Compound (IS-5831, ASTM-D2843, IS10810(Part 58) ,IEC-60754 Part-1)	Y		Y								Y	Y					Y	
	Triple Extrusion & curing /Manufacturing of Core		Y			Y		Y											
	Copper Tape	Y	Y	Y			Y												
	Polyster tape	Y	Y																
	Core Laying								Y										
	Armour wire/strip	Y	Y	Y															
	Copper tapping	Y	Y												Y				
	Inner sheath	Y	Y																
	Armouring		Y							Y									
	Outer Sheathing		Y								Y								
	Power Cable (Finished)								Y	Y	Y	Y	Y				Y	Y	
	Wooden drum(IS-10418) /Steel Drum		Y													Y	Y		
	Notes:																		
	1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.																		
2. Make of all major Bought out items will be subject to NTPC approval.																			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH					TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9					PART-F					Page 321 of 415				

CLAUSE NO.	TECHNICAL SPECIFICATIONS		
	ROUTINE TESTS		Following routine tests shall be carried out on each drum of finished cables for all types & sizes.
	3)	Conductor Resistance test	
	4)	High voltage test	
	5)	Partial discharge test (for Screened cables only)	
	ACCEPTANCE TESTS		Following Acceptance tests shall be carried out on each size of each type (voltage rating) of cables, in the offered lot.
	A) For Conductor (as per sampling plan mentioned in IS: 7098 Part II)		
		3)	Annealing test (Copper)
		4)	Tensile Test (Aluminum)
		5)	Wrapping Test (Aluminum)
		6)	Resistance test
	B) For copper tape / Wires (as per sampling plan mentioned in IS: 7098 Part II)		
		1)	Measurement of Dimensions
		2)	Conductivity check
	B) For Armour Wires / Formed Wires (If applicable) (as per sampling plan mentioned in IS: 7098 Part II)		
		11.	Measurement of Dimensions
		12.	Tensile Tests
		13.	Elongation Test
		14.	Torsion Test For Round wires only
		15.	Wrapping Test
		16.	Resistance Test
		17.	Mass of Zinc coating test For G S wires / Formed wires only
		18.	Uniformity of Zinc coating For G S wires / Formed wires only
		19.	Adhesion test For G S wires / Formed wires only
		20.	Freedom from surface defects
	C) For XLPE insulation & PVC Sheath (as per sampling plan mentioned in IS: 7098 Part II)		
	3)	Test for thickness	
	4)	Tensile strength & Elongation before ageing (for tests after ageing see "D")	
	5)	Hot set test (For XLPE insulation)	
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH			
TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9			
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CLAUSE NO.	<div>  TECHNICAL SPECIFICATIONS </div>			
D)	Ageing test:			
	Criteria	Condition	Test Requirements	Remarks
PVC outer sheath :	Samples as per relevant IS, from each size of each type (voltage rating) of cables in the offered lot, shall be tested for tensile strength & elongation (before ageing). Tensile & elongation testing shall preferably be done with a computerized machine. The values will be compared with corresponding values mentioned in the Type Test report accepted by NTPC. These values of Tensile Strength & Elongation (before ageing) should be within + / - 15% of the corresponding values of Type Test report. (Please note that test values should be more than the minimum values indicated in relevant standard).	All sizes which meet the criteria	For PVC: The size which has maximum negative deviation from type test report values will be put on accelerated ageing test. The samples shall be aged in air oven at temperature of 130°C +/- 2°C for 5 hours and tested for TS & elongation. Acceptance norms shall be as per IS.	In case the size does not meet the requirement in accelerated ageing test then all sizes (which had met the criteria) will be put on ageing test as per IS.
		Sizes which do not meet the criteria	Every size will be put on ageing test as per IS.	----
XLPE Insulation	Samples as per relevant IS, from each size of each type (voltage rating) of cables in the offered lot, will be put on ageing test as per IS.			
E)	Following tests will be carried out on completed cables as per IS on each size of each type			
	1) Insulation resistance test (Volume resistivity method)			
	2) High voltage test			
	3) Partial discharge test (for Screened cables only)			
F)	Following tests shall be carried out on only one size of offered lot (comprising of all sizes & types)			
	1) Thermal stability test on outer sheath			
	2) Oxygen index test on outer sheath			
	3) Smoke density rating test on outer sheath			
	4) Acid gas generation test on outer sheath			
	5) Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cable			
G)	Following tests shall be carried on one length of each size of each type of offered lot:			
	1) Constructional / dimensional check, surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Sequential marking, marking of drum no. / Batch number of outer sheath extrusion			
	2) Measurement of Eccentricity & Ovality			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9		PART-F Page 323 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS																	
	LT Power Cables																	
	Attributes / Characteristics																	
	Item / Components / Sub System Assembly	Make, Type & T.C as per relevant standard	Dimension/surface finish	Mechanical properties	Chemical Composition	Spark Test(as applicable)	Electrical properties	Hot Set Test/ Eccentricity & Ovality	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two wires	Sequential marking/ Batch marking/ surface finish/ cable length	T.S & elongation before & after ageing on outer sheath & insulation	Thermal stability	Anti termite coating on wooden drums	Constructional requirements feature as per NTPC specification	Routine & Acceptance Tests as per relevant standard & NTPC specification	FRLS Tests	
	Aluminum (IS-8130)	Y	Y	Y	Y		Y											
	XLPE Compound (IS-7098)	Y		Y			Y	Y				Y						
	PVC insulation Compound (IS: 5831)	Y		Y			Y					Y	Y					
	FRLS PVC Compound (IS-5831, ASTM-D2843, IS10810(Part 58), IEC-60754 Part-1)	Y		Y								Y	Y				Y	
	Extrusion & curing /Manufacturing of Core (PVC / XLPE)		Y			Y		Y					Y					
	Core Laying								Y									
	Armour wire/strip	Y	Y	Y														
	Inner sheath	Y	Y															
	Armouring		Y							Y								
	Outer Sheathing		Y								Y							
	Power Cable (Finished) (IS-5831, ASTM-D2843, IS10810(Part 58), IEC-60754 Part-1, IEC 60332 part III cat B)								Y	Y	Y	Y	Y		Y	Y	Y	
	Wooden drum(IS-10418) /Steel Drum		Y											Y	Y			
	Notes:																	
	1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.																	
	2. Make of all major Bought out items will be subject to NTPC approval.																	
	DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH				TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9				PART-F				Page 324 of 415					

CLAUSE NO.	TECHNICAL SPECIFICATIONS					
	ROUTINE TESTS		Following routine tests shall be carried out on each drum of finished cables for all types (PVC / XLPE insulated) & sizes.			
	6)		Conductor Resistance test			
	7)		High voltage test			
	ACCEPTANCE TESTS		Following Acceptance tests shall be carried out on each size of each type (PVC / XLPE insulated) of cables, in the offered lot.			
	A) For Conductor (as per sampling plan mentioned in IS: 1554 / 7098)					
			1)	Annealing test (Copper)		
			2)	Tensile Test (Aluminum)		
			3)	Wrapping Test (Aluminum)		
			4)	Resistance test		
	B) For Armour Wires / Formed Wires (If applicable) (as per sampling plan mentioned in IS: 1554 / 7098)					
			1.	Measurement of Dimensions		
			2.	Tensile Tests		
			3.	Elongation Test		
			4.	Torsion Test For Round wires only		
			5.	Wrapping Test		
			6.	Resistance Test		
			7.	Mass of Zinc coating test For G S wires / Formed wires only		
			8.	Uniformity of Zinc coating For G S wires / Formed wires only		
			9.	Adhesion test For G S wires / Formed wires only		
			10.	Freedom from surface defects		
	C) For PVC / XLPE insulation & PVC Sheath (as per sampling plan mentioned in IS: 1554 / 7098)					
			1)	Test for thickness		
			2)	Tensile strength & Elongation before ageing (for tests after ageing see "D")		
			3)	Hot set test (For XLPE insulation)		
	D) Ageing test:					
			Criteria	Condition	Test Requirements	Remarks
	PVC insulat ion & outer sheath :	Samples as per relevant IS, from each size of cables in the offered lot, shall be tested for tensile strength & elongation (before ageing). Tensile & elongation testing shall preferably be done with a computerized machine. The values will be compared with corresponding values mentioned in the Type Test report accepted by NTPC. These values of Tensile Strength & Elongation (before ageing) should be	All sizes which meet the criteria	The size which has maximum negative deviation from type test report values will be put on accelerated ageing test. The samples shall be aged in air oven at temperature of 130°c+/- 2°c for 5 hours and tested for TS & elongation. Acceptance norms shall be as per IS.	In case the size does not meet the requirement in accelerated ageing test then all sizes (which had met the criteria) will be put on ageing test as per IS.	
	DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9		PART-F	Page 325 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS				
		within +/- 15% of the corresponding values of Type Test report. (Please note that test values should be more than the minimum values indicated in relevant standard).	Sizes which do not meet the criteria	Every size will be put on ageing test as per IS.	----
	XLPE insulation	Samples as per relevant IS, from each size of cables in the offered lot, will be put on ageing test as per IS.			
	E) Following tests will be carried out on completed cables as per IS on each size of each type (PVC / XLPE insulated)				
		1)	Insulation resistance test (Volume resistivity method)		
		2)	High voltage test		
	F) Following tests shall be carried out on only one size of offered lot (comprising of all sizes & types)				
		1)	Thermal stability test on PVC insulation and outer sheath		
		2)	Oxygen index test on outer sheath		
		3)	Smoke density rating test on outer sheath		
		4)	Acid gas generation test on outer sheath		
	G) Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cables as per following sampling plan:				
			This test will be carried out using composite sampling i.e. irrespective of size; cables of one particular type (i.e. armoured PVC insulated, unarmoured PVC insulated, armoured XLPE insulated, unarmoured XLPE insulated) will be bunched together, as per calculations in line with the IEC. All sizes of PVC & XLPE insulated, armoured & unarmoured cables shall be covered. For one particular type, cables with OD less than or equal to 30 mm shall be clubbed together in touching formation while cables with OD greater than 30 mm shall be clubbed together leaving a gap equal to OD of cable having least diameter. Cable OD shall be taken as nominal overall diameter as per NTPC approved datasheet.		
	H) Following tests shall be carried on one length of each size of each type (PVC / XLPE insulated) of offered lot:				
		1)	Constructional / dimensional check, surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Sequential marking, drum / Batch (outer sheath extrusion batch)number marking on sheath		
		2)	Measurement of Eccentricity & Ovality		
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9		PART-F	Page 326 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS															
	CONTROL DESK, PLC /SCADA PANEL, SMOKE DETECTOR, FIRE ALARM & CONTROL SYSTEM															
	CONTROL DESK, PLC /SCADA PANEL, SMOKE DETECTOR, FIRE ALARM & CONTROL SYSTEM															
	ITEMS	TESTS														
		Visual ®	GA, BOM ,Lay Out of components ®	Dimensions ®	Paint Shade/Thickness/Adhesion ®	Alignment of Section ®	Component Rating/ Make / Type ®	Wiring ®	IR & HV ®	Review of TC for instruments/ Devices/ Recorders, Indicators/ osaic Items/ Transducers ®	Accessibility of TBS/ Devices ®	Illumination ®	Functional Check for Control Element , Annunciation ®	Mimic ®	Test as per IEC 1131 ® *	Test as per Std ® & (A)
	1. Control Desk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
2. Annunciation, Control, PLC/SCADA Panel	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y	
3.Smoke Detectors (UL-268,EN-54 PT-7), Heat Detectors(UL-521/EN 54 PT-5) Annunciation/ Control Panel (UL -864, EN-54, PT-2)															Y	
<p>Note: 1) Detailed procedure of Environmental Stress Screening test shall be as per Quality Assurance Programme in General Technical Conditions</p> <p>2) This is an indicative list of test/ checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and Procedure alongwith relevant supporting documents.</p> <ul style="list-style-type: none">*Applicable for PLCY - Test Applicable , ® - Routine Test (A) - Acceptance Test																
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9				PART-F				Page 327 of 415						


CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	<div><p>Note : High Temp. cables shall be subjected to tests as per VDE-207(Part-6) Compensating cables shall be checked for Thermal EMF/Endurance test as per IS 8784.</p><p>Note : This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalization for all items.</p><p>Note : ® - Routine Test A - Acceptance Test Y - Test Applicable</p><p>Note : Sampling Plan for Acceptance test shall be as per IS 8784 (As applicable)</p><ul style="list-style-type: none">• * FRLS Tests: Oxygen / Temp Index (ASTM D-2863), Smoke Density Rating (ASTM – D 2843), HCL Emission (IEC-754-1)• ** Characterisitic Impedence, Attenuation, Mutual Capacitance, Cross Talk (As applicable)<p>+ Sample size will be One No. of each size/type per lot.</p><p>++ Sample size will be One No. sample for complete lot offered irrespective of size/type.</p></div>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9	PART-F	Page 329 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS																																																																																																																												
	DC SYSTEM SQE_19																																																																																																																												
	<div>LEAD ACID BATTERY</div> <table><tr><th>ATTRIBUTES / CHARACTERISTICS</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></tr><tr><td>ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY</td><td>Dimensions & Finish</td><td>Conformance to relevant part drg. & Manufacturer's standards</td><td>Chemical composition</td><td>Lead Coating Thickness (min. 25 microns, IS: 6848 App.F) & Adhesion Check</td><td>Conformance to CPWD Spec. for Teak Wood</td><td>Paint Process checks, Paint Shade, Thickness, Adhesion & Finish</td><td>Constructional requirements as per NTPC Spec.</td><td>Routine & acceptance tests as per relevant standard</td></tr><tr><td>Container & Lids (IS : 1146)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Vent Plugs</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Sealing Compound (IS : 3116)</td><td></td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Positive & Negative Plates</td><td></td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Separators (IS : 6071)</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Electrolyte (Water / Sulphuric Acid) (IS : 1069 / 266)</td><td></td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Inter-cell Connectors & Fasteners</td><td>Y</td><td>Y</td><td></td><td>Y</td><td></td><td></td><td></td><td></td></tr><tr><td>Battery Stand</td><td>Y</td><td>Y</td><td></td><td></td><td>Y</td><td>Y</td><td></td><td></td></tr><tr><td>Cell Insulators</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Stack Assembly</td><td>Y</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Lead Acid Battery (IS : 1652)</td><td>Y</td><td></td><td></td><td></td><td></td><td></td><td>Y</td><td>Y</td></tr></table> <div>Note: This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.</div>								ATTRIBUTES / CHARACTERISTICS									ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimensions & Finish	Conformance to relevant part drg. & Manufacturer's standards	Chemical composition	Lead Coating Thickness (min. 25 microns, IS: 6848 App.F) & Adhesion Check	Conformance to CPWD Spec. for Teak Wood	Paint Process checks, Paint Shade, Thickness, Adhesion & Finish	Constructional requirements as per NTPC Spec.	Routine & acceptance tests as per relevant standard	Container & Lids (IS : 1146)	Y	Y							Vent Plugs	Y	Y							Sealing Compound (IS : 3116)		Y	Y						Positive & Negative Plates		Y	Y						Separators (IS : 6071)	Y	Y							Electrolyte (Water / Sulphuric Acid) (IS : 1069 / 266)		Y	Y						Inter-cell Connectors & Fasteners	Y	Y		Y					Battery Stand	Y	Y			Y	Y			Cell Insulators	Y	Y							Stack Assembly	Y	Y							Lead Acid Battery (IS : 1652)	Y						Y	Y
ATTRIBUTES / CHARACTERISTICS																																																																																																																													
ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimensions & Finish	Conformance to relevant part drg. & Manufacturer's standards	Chemical composition	Lead Coating Thickness (min. 25 microns, IS: 6848 App.F) & Adhesion Check	Conformance to CPWD Spec. for Teak Wood	Paint Process checks, Paint Shade, Thickness, Adhesion & Finish	Constructional requirements as per NTPC Spec.	Routine & acceptance tests as per relevant standard																																																																																																																					
Container & Lids (IS : 1146)	Y	Y																																																																																																																											
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Sealing Compound (IS : 3116)		Y	Y																																																																																																																										
Positive & Negative Plates		Y	Y																																																																																																																										
Separators (IS : 6071)	Y	Y																																																																																																																											
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Inter-cell Connectors & Fasteners	Y	Y		Y																																																																																																																									
Battery Stand	Y	Y			Y	Y																																																																																																																							
Cell Insulators	Y	Y																																																																																																																											
Stack Assembly	Y	Y																																																																																																																											
Lead Acid Battery (IS : 1652)	Y						Y	Y																																																																																																																					
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH	TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9			PART-F		Page 330 of 415																																																																																																																							


CLAUSE NO.	TECHNICAL SPECIFICATIONS								<div>एनटीपीसी NTPC</div>
	Ni- Cd BATTERY								
	ATTRIBUTES / CHARACTERISTICS → ↓ ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimensions & Finish	Impact Strength	Conformance to relevant part drg. & Manufacturer's standards	Resistance to Alkali	Chemical composition	Nickel Plating thickness	Paint Shade, Thickness, Adhesion & Finish	Routine & acceptance tests as per relevant standard
	Container & Lids	Y	Y	Y	Y				
	Vent Plugs	Y		Y	Y				
	Perforated Steel Strips	Y		Y	Y		Y		
	Active Material for Positive & Negative Plates			Y		Y			
	Separators	Y		Y	Y				
	Electrolyte			Y		Y			
	Inter-cell Connectors & Fasteners	Y		Y	Y		Y		
	Battery Stand	Y			Y			Y	
	Cell Insulators	Y		Y	Y				
	Stack Assembly	Y		Y					
	Ni-Cd Battery (IS : 10918)	Y							Y
	Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Makes of all major Bought Out Items will be subject to NTPC approval.								
	DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH				TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9		PART-F		Page 331 of 415


CLAUSE NO.	TECHNICAL SPECIFICATIONS														
	BATTERY CHARGER														
	BATTERY CHARGER														
	Attributes / Characteristics →	Make, Model, Type, Rating & Finish	Verification of Routine test reports as per relevant IS	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard & NTPC spec	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per NTPC approved drgs & specification	Temperature Rise Test	Ripple Content Test, Load Limiter & AVR Operation Test	Dynamic Response Test	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50°C for 48 hrs in energised condition	Alternating current measurement test	Degree of Protection Test as per NTCP Spec.
	Items / Components / Sub- assembly ↓														
	Rectifier Transformer and Reactors IS : 4540, 2026)	Y	Y		Y			Y				Y			
	Electronic Components including Potentiometer (Vernier Type)	Y			Y		Y								
	Electronic Cards	Y			Y								Y		
	PCB & racks for electronic cards	Y					Y								
	Control & Selector Switches (IS : 6875)	Y			Y						Y				
	Indicating Meters (IS : 1248)	Y			Y						Y				
	Indicating Lamps (IS: 13947)	Y			Y						Y				
	Air Break Switches / Fuses (IS : 13947 / 13703)	Y			Y						Y				
	Control Terminal Blocks (IS : 13947)	Y			Y										
	Control Transformer (IS : 12021)	Y			Y						Y				
	Push Buttons (IS : 4794)	Y			Y						Y				
	MCB (IS : 8828)	Y			Y						Y				
	PVC insulated Copper control wires (IS : 694)	Y			Y										
	Sheet Steel (IS : 513)	Y		Y	Y										
	Synthetic Rubber Gaskets	Y			Y										
	Annunciator	Y									Y		Y		
Battery Charger	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Makes of all major Bought Out Items will be subject to NTPC approval.															
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH				TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9				PART-F			Page 332 of 415				


CLAUSE NO.	TECHNICAL SPECIFICATIONS										
	<div>BATTERY CHARGER (of capacity upto 24 V / 48 V , 150 A DC)</div>										
	<div>BATTERY CHARGER (of capacity upto 24 V / 48 V , 150 A DC)</div>										
	Attributes / Characteristics →										
		Make, Model, Type, Rating	Dimensional check and Paint shade, thickness, adhesion	Complete physical examination for constructional features as per approved drgs	Ripple Content Test, Load Limiter operation & AVR	Operational & Functional Checks of aux. Devices like annunciator, switches, indicators etc.	HV & IR Test	Burn-In Test	Dynamic response test	AC input current measurement test	Temperature rise test
Battery Charger	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
<div>Note</div> <div>1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.</div> <div>2. Makes of all major Bought Out Items will be subject to NTPC approval.</div>											
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH				TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9				PART-F		Page 333 of 415	


CLAUSE NO.	TECHNICAL SPECIFICATIONS											
<div>DC HEALTH MONITORING SYSTEM</div>	DC HEALTH MONITORING											
	SYSTEM											
	Attributes / Characteristics											
	Items / Components / Sub- assembly	Make, Model, Type, Rating & Finish	Verification of Routine test reports as per relevant IS	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard & NTPC spec	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per NTPC approved drgs & specification	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50°C for 48 hrs in 334energized condition	Degree of Protection Test as per NTPC Spec.	
	Enclosure	Y		Y	Y	Y					Y	
	Synthetic Rubber Gaskets	Y			Y							
	Control & Selector Switches ,Indicating Meters, Indicating Lamps	Y			Y			Y				
	Control Terminal Blocks ,Push Buttons, MCB	Y			Y			Y				
	MCB	Y			Y			Y				
	PVC insulated Copper control / signal cables	Y	Y		Y							
	Transducers / detectors	Y	Y		Y			Y				
	PCB & racks for electronic cards	Y										
	Electronic Cards	Y						Y		Y		
	Microprocessor Based Controller	Y						Y		Y		
	SCADA	Y						Y				
	Software	Y						Y				
	DC Health Monitoring System	Y			Y	Y	Y	Y	Y	Y	Y	
	Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Makes of all major Bought Out Items will be subject to NTPC approval.											
	DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH				TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9				PART-F		Page 334 of 415	

CLAUSE NO.		TECHNICAL SPECIFICATIONS															
		STATION LIGHTING										SQE_17					
Item Components Sub System Assembly	Attributes Characteristics	Make, Type , Rating/ TC	Dimension	Pre-Treatment of sheat	Paint Shade Thickness	Adhesion & Finish	Galvanization Tests	IP Test	Bought Out Items/ Bill of Material	HV & IR	Functional Check as per spec.	Constructional Feature as per NTPC spec.	Routine Test as per relevant std and spec	Acceptance Test as per relevant std and spec	Item to conform to relevant standard		
	Luminaries (IS-10322 Part-5 Sec.1 (non –LED type)	Y						Y		Y			Y	Y	Y		
	Electronic Ballast	Y											Y	Y	Y		
	Lighting Wire (IS-694)	Y											Y				
	Fans (IS-374)	Y											Y				
	Pole (IS-2713)	Y			Y							Y	Y	Y			
	Lamps (IS-9800, IS-9974)	Y											Y	Y			
	Lighting Mast (with raise & lower lantern type)	Y	Y				Y					Y	Y	Y			
	Wall Mounted Lighting Panel (IS-513, IS-5)	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			
	Switch Box/ Junction Box/Receptacles/ Local Push Button Station / Lighting Panel (IS-513, 2629, 2633, 4759, 6745)	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			
	Cable Gland (BS-6121)	Y	Y										Y				
	Cable Lug (IS-8309)	Y	Y										Y				
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9										PART-F				Page 335 of 415	

CLAUSE NO.	<div>  TECHNICAL SPECIFICATIONS </div>												
	Flexible Conduit	Y										Y	
	Lighting Transformer (IS-11171)	Y								Y		Y	
	Epoxy & Galvanised Conduit (IS-9537, 2629, 2638, 4759, 6745)	Y	Y									Y	Y
<p>LED Luminaire quality requirements:</p> <ol style="list-style-type: none"> 1) LED modules to conform to IS: 16103 part 2. Manufacturer to issue a certificate of compliance for the same. 2) Control gear to conform to IS 15885 part 2 section 13. Manufacturer to issue a certificate of compliance for the same. 3) LED luminaire to conform to IS 16107 part 2 section 1. Manufacturer to issue a certificate of compliance for the same. 4) LED luminaire marking to be as per IS 16107 part 2 section 1. Manufacturer to issue a certificate of compliance for the same. 5) Acceptance tests as per IS 16107 part 2 section 1 to be carried out on LED luminaire except long duration tests i.e. a) Chromaticity coordinates & correlated color temperature (CCT); b) Color rendering index (CRI). Manufacturer will submit a COC for above tests i.e. CCT & CRI 6) LED driver make, model, type & rating may be as per recommendations of LED module manufacturer. <p>Notes:</p> <ol style="list-style-type: none"> 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Make of all major Bought Out Items will be subject to NTPC approval. 													
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH				TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9				PART-F			Page 336 of 415		

CLAUSE NO.	TECHNICAL SPECIFICATIONS																		
	POWER SUPPLY FOR C&I SYSTEMS (UPS/BATTERY/BATTERY CHARGER/ACDB/DCDB)																		
	TESTS	Visual/dimension/rating/ Paint Adhesion/ Thickness (R)	General arrangement/BOM/make of components /Mimic ®	Efficiency ,regulation(R)	Input voltage variation (A)	Out put voltage and frequency adj.range(A)	Premilinary light load test(R)	Load transfer retransfer test (R) *	AC input failure and return test (R)	Parralel operation and current divison(R)	Relative harmonic content(R)	Restart with PRI A.C and battery (separately)(R)	System transfer and retransfer (R)*	Asynchronous transfer(R)	Ripple content(R)	Load limiter operation (R)	IR/HV(R)	Tests as per standard &specification (R)&(A)	
	ITEMS																		
	UPS/CONVE RTER (IEC-146 PT-4)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	VOLTAGE STABILISER	Y	Y	Y	Y	Y					Y		Y				Y		
	LEAD ACID BATTERY(T UBLAR)-IS-1651																	Y	
	LEAD ACID BATTERY (PLANTE)-IS-1652																	Y	
	NICKEL CADMIUM BATTERY(IS -10918/IEC-623)																	Y	
	SMF BATTERY																	Y	
	ACDB/DCDB	Y	Y															Y	Y
	BATTERY CHARGER	Y	Y	Y	Y	Y				Y					Y	Y	Y	Y	
	R-Routine Test		A- Acceptance Test								Y – Test applicable								
	* Transfer time and Over shoot /under shoot during load & system transfer shall be recorded .																		
	Note: 1) Detailed procedure of Environmental Stress Screening test shall be as per Quality Assurance Programme in General Technical Conditions																		
	2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.																		
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH				TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9						PART-F				Page 337 of 415					


CLAUSE NO.	TECHNICAL SPECIFICATIONS													
	OIL TRANSFORMER													
	Attributes / Characteristics													
	Items/Components Sub Systems	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	Functional check	WPS & PQR	Routine Test as per relevant standard / NTPC Specification
	Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y					Y					Y	
	Conservator / Radiator / Cooler / Pipes	Y	Y					Y						
	Copper Conductor (IS:191)	Y	Y	Y		Y								
	Insulating Material	Y	Y	Y	Y	Y	Y							
	CRGO Lamination & Built Core	Y	Y	Y		Y	Y				Y			
	Bushing / Insulator (IS:2544 / 5621)	Y	Y								Y			Y
	Gasket	Y	Y			Y	Y		Y		Y			Y
	Transformer Oil (IEC296)			Y										Y
	OLTC / Off-Circuit Tap Changer	Y									Y			Y
	Core Coil Assembly & Pre-tanking	Y								Y	Y			
	Marshalling Box	Y									Y	Y		Y
	WTI, OTI, MOG, PRD, Breather, Terminal Connector, Bucholz Relay, Valves	Y									Y	Y		
Welding (ASME Sect-IX)	Y						Y					Y		
Complete Transformer (IS:2026/ IEC-60076)	Y												Y	
Note: 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2) All major Bought Out Items will be subject to NTPC approval.														
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH				TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9					PART-F		Page 338 of 415			

CLAUSE NO.	<div>  TECHNICAL SPECIFICATIONS </div>																																																																																																															
<div> <div>SWITCHYARD SQE_20</div> <table> <tr> <th>Attributes / Characteristics</th> <th>Make, model, Type & Rating, Test Certificate</th> <th>Routine & Acceptance Test as per IS / IEC</th> <th>Functional requirements as per NTPC Specification</th> </tr> <tr> <th>Items/Components Sub Systems</th> <th></th> <th></th> <th></th> </tr> <tr> <td>Circuit Breaker (IEC:62271-100)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Hollow insulator (IEC:233/ IS:5621)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Isolator (IEC:62271-102)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Current Transformer (IEC:60044/BS:3938/IS2705/ IEC: 61869)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Capacitor Voltage Transformer (IEC:186A / 358/IS3156/IEC60044/ IEC: 61869)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Bus Post Insulator (IEC:168 / 815 / IS:2544)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Disc, Pin & String Insulator (IEC:383 / IS:731)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Surge Arrestor (IEC:99-4/IS:3070)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Hardware fittings for Insulator (IS:2486 / BS:3288)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Spacers, Clamps & Connector (IS:10162 / 5561/ 617)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Aluminium Tube (IS:5082 / 2673 / 2678)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Conductor (IS:398)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Galvanised Steel Structures (IS:2062/2629/4759/6745)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Vibration Damper (IS:9708)</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Sag Compensating Spring DIN:2089/2096 IS:3195 / 7906</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Control & Relay Panel / SAS</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>SF6 Gas filling & evacuating plant</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>SF6 Gas Leak Detector</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Leakage Current Analyser</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Nitrogen Gas Filling Device</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Protection Relays</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Event Logger</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Operation Analyser</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Disturbance Recorder</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> <tr> <td>Synchronising Trolley</td> <td>Y</td> <td>Y</td> <td>Y</td> </tr> </table> </div>	Attributes / Characteristics	Make, model, Type & Rating, Test Certificate	Routine & Acceptance Test as per IS / IEC	Functional requirements as per NTPC Specification	Items/Components Sub Systems				Circuit Breaker (IEC:62271-100)	Y	Y	Y	Hollow insulator (IEC:233/ IS:5621)	Y	Y	Y	Isolator (IEC:62271-102)	Y	Y	Y	Current Transformer (IEC:60044/BS:3938/IS2705/ IEC: 61869)	Y	Y	Y	Capacitor Voltage Transformer (IEC:186A / 358/IS3156/IEC60044/ IEC: 61869)	Y	Y	Y	Bus Post Insulator (IEC:168 / 815 / IS:2544)	Y	Y	Y	Disc, Pin & String Insulator (IEC:383 / IS:731)	Y	Y	Y	Surge Arrestor (IEC:99-4/IS:3070)	Y	Y	Y	Hardware fittings for Insulator (IS:2486 / BS:3288)	Y	Y	Y	Spacers, Clamps & Connector (IS:10162 / 5561/ 617)	Y	Y	Y	Aluminium Tube (IS:5082 / 2673 / 2678)	Y	Y	Y	Conductor (IS:398)	Y	Y	Y	Galvanised Steel Structures (IS:2062/2629/4759/6745)	Y	Y	Y	Vibration Damper (IS:9708)	Y	Y	Y	Sag Compensating Spring DIN:2089/2096 IS:3195 / 7906	Y	Y	Y	Control & Relay Panel / SAS	Y	Y	Y	SF6 Gas filling & evacuating plant	Y	Y	Y	SF6 Gas Leak Detector	Y	Y	Y	Leakage Current Analyser	Y	Y	Y	Nitrogen Gas Filling Device	Y	Y	Y	Protection Relays	Y	Y	Y	Event Logger	Y	Y	Y	Operation Analyser	Y	Y	Y	Disturbance Recorder	Y	Y	Y	Synchronising Trolley	Y	Y	Y				
	Attributes / Characteristics	Make, model, Type & Rating, Test Certificate	Routine & Acceptance Test as per IS / IEC	Functional requirements as per NTPC Specification																																																																																																												
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	Bus Post Insulator (IEC:168 / 815 / IS:2544)	Y	Y	Y																																																																																																												
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	Surge Arrestor (IEC:99-4/IS:3070)	Y	Y	Y																																																																																																												
	Hardware fittings for Insulator (IS:2486 / BS:3288)	Y	Y	Y																																																																																																												
	Spacers, Clamps & Connector (IS:10162 / 5561/ 617)	Y	Y	Y																																																																																																												
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	Conductor (IS:398)	Y	Y	Y																																																																																																												
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DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9		PART-F	Page 339 of 415																																																																																																											

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	<div>Attributes / Characteristics</div> <div>Items/Components Sub Systems</div>	Make, Type Rating, and Model, Test Certificates	Routine & Acceptance Test as per relevant IS/IEC	Functional requirements as per NTPC Specification
	Relay Test Kit	Y	Y	Y
	Surge Monitor	Y	Y	Y
	<div>Notes : 1) This is an indicative list of test/checks. The manufacture is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalisation for all items.</div> <div>2) All major Bought Out Items will be subject to NTPC approval.</div>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9	PART-F	Page 340 of 415


CLAUSE NO.	<div>एनटीपीसी NTPC</div> TECHNICAL SPECIFICATIONS		
	<p style="text-align: center;">FIRE EXTINGUISHERS</p> <p>a) All fire extinguishers shall be tested as per relevant standard.</p> <p>b) Performance / function test shall be carried out on sampling basis as per relevant code / standard.</p>		
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH	TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9	PART-F	Page 341 of 415


CLAUSE NO.	TECHNICAL SPECIFICATIONS						<div>एनटीपीसी NTPC</div>
	Energy Meter						
	Attributes / Characteristics →	Make, Model, Type, Rating & Finish	Conform to relevant Standard & NTPC spec	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per NTPC approved drgs & specification	Burn-In Test and Elevated Temperature Test as per specification	All routine & acceptance tests as per IS 13779
	Items / Components/ Sub- assembly↓						
	Electronic Components						
	PCB for electronic cards						
	Electronic Cards						
	Terminal Blocks as per IS 13779						
	Instrument Transformer CTs & PTs (IS : 2705 & IS 3156)						
	Sheet Steel (IS : 513)						
	Synthetic Rubber Gaskets IS 11149						
	Energy meter IS 13779						
	Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Makes of all major Bought Out Items will be subject to NTPC approval.						
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9		PART-F		Page 342 of 415	


CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	<u>Module Cleaning and Ventilation Quality Requirements</u>			
	<div><div>A. Module Cleaning System:</div><div><div>• Pipes, Valves, Pumps etc shall be tested as per requirements of relevant standard.</div></div><div>B. VENTILATION SYSTEM</div><div><div>• Split/Window Cassette Air conditioner less than 10 TR will be accepted on the basis of Manufacturer Standard Guarantee and Warrantee certificate.</div><div>• Fans, Filters etc shall be tested as per requirements of relevant standard.</div></div></div>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9	PART-F	Page 343 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS									
	CLOSED CIRCUIT TELEVISION SYSTEM (CCTV) – IP Based									
	Attributes Characteristics									
	Item Components Sub System Assembly	Make, Model, Type, Rating, TC®	Dimension/constructional requirement®	Functional/operational check®	Switching capability and sequence®	No. of inputs/outputs, display®	Provision for connectivity with the LVS®	Pan range/speed, tilt/tilt speed®	Operational check from key board/control	Commands from LAN Switch/Network Switch®
	LAN Switch/Network Switch	Y		Y	Y	Y	Y			
	Key boards	Y		Y						
	Cameras	Y	Y	Y						
	Lens	Y	Y	Y						
	Camera Housing	Y	Y	Y						
	Pan & Tilt unit	Y	Y	Y				Y		
	Media Converter	Y		Y						
	Monitor	Y	Y	Y						
	Software	Y		Y						
	Server, Work Station, Storage Device	Y		Y						
	Complete System	Y	Y	Y	Y	Y	Y	Y	Y	Y
	<p>Note : 1)Detailed procedure of Environmental Stress Screening test shall be as per Quality Assurance Programme in General Technical Conditions</p> <p>2) This is an indicative list of test/checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure alongwith relevant supporting documents.</p> <p>R –Routine Test Y -Test Applicable</p>									
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH			TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9				PART-F		Page 344 of 415	

CLAUSE NO.	TECHNICAL SPECIFICATIONS			<div>एनटीपीसी NTPC</div>
	<div>QUALITY ASSURANCE AND INSPECTION FOR CIVIL WORKS</div>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH	TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9	PART-F	Page 345 of 415	

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
3.	LABORATORY AND FIELD TESTING			
	<p>The field laboratory for QA and QC activities shall be constructed and set-up by the contractor in line with the indicative field QA&QC laboratory set-up enclosed at Annexure-I. The Laboratory building shall be constructed and installed with the adequate facilities to meet the requirement of envisaged test setup. Temperature and humidity controls shall be available wherever necessary during testing of samples. The quality plan shall identify the testing equipments/ instrument, which the contractor shall deploy and equip the field quality laboratory for meeting the field quality plan requirements. The contractor shall furnish a comprehensive list of testing equipments/ instrument required to meet the planned/scheduled tests for the execution of works for NTPC acceptance/ approval. The contractor shall mobilize the requisite laboratory equipment and QA&QC manpower at least 15 days prior to the planned test activity as per the schedule of tests.</p> <p>All equipments and instruments in the field shall be calibrated before the commencement of tests and then at regular intervals, as per the manufacturer's recommendation and as directed by the NTPC. The calibration certificates shall specify the fitness of the equipments and instruments within the limit of tolerance for use. Contractor shall arrange for calibration of equipments and instruments by an NABL / NPL accredited agency and the calibration report shall be submitted to NTPC.</p> <p>The tests which cannot be carried out in the field laboratory shall be done at a laboratory of repute. This includes selected IITs, NCB, CSMRS, reputed government / autonomous laboratories / organizations, NITs and other reputed testing laboratories. The test samples for such test shall be jointly selected and sealed by the engineer and thereafter these shall be sent to the concerned laboratory through the covering letter signed by NTPC engineer. The test report along with the recommendations shall be obtained from the laboratories without delay and submitted to NTPC.</p> <p>Based on the schedule of work agreed with the engineer-in-charge and the approved FQP, the contractor shall prepare a schedule of tests and submit them to the engineer-in-charge and organize to carry out the tests as scheduled / agreed.</p>			
4.	SAMPLING AND TESTING OF CONSTRUCTION MATERIALS			
	<p>The method of sampling for testing of construction materials and work / job samples shall be as per the relevant IS / standards / codes and in line with the requirements of the technical specifications / quality plans. All samples shall be jointly drawn, signed and sealed wherever required, by the contractor and the engineer or his authorized representative.</p> <p>The contractor shall carry out testing in accordance with the relevant IS / standards / codes and in line with the requirements of the technical specifications / quality plans. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9	PART-F	Page 347 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
5.	<p>Engineer. All testing shall be done in the presence of the engineer or his authorized representative in a NABL accredited / Govt. Laboratory acceptable to NTPC. This includes all IITs, NCB, CSMRS, reputed government / autonomous laboratories / organizations, NITs and other reputed testing laboratories. The test samples for such test shall be jointly selected and sealed by the engineer and thereafter these shall be sent to the concerned laboratory through the covering letter signed by NTPC engineer. The test report along with the recommendations shall be obtained from the laboratories without delay and submitted to NTPC.</p>			
	<p>PURCHASE AND SERVICE</p> <p>All structural steel shall be procured from main steel producers like SAIL, TISCO, RINL, Essar Steel, Ispat Industries, JSW Steel, Lloyds Steel Industries, Jindal Steel & Power and Sunflag Steel & Iron Co., Bhandara [only for rounds (15-105 mm), flats (45-120 mm width & 4.75-28 mm thick), hex rods (15.5-42 mm) and wire rods (5.5-38 mm)]. In case of non-availability of some of the sections with main steel producers the contractor may propose to procure the sections from the re-rollers of the main steel producers, the name of such re-rollers will have to be cleared by corporate quality assurance of NTPC for which details such as BIS approval, main steel producer's approval, past experience for production of sections of specified material, details of machines plants testing facilities etc., Confirmation that the process control and manufacturing of steel sections by re-rollers shall be same as that of main steel producers, that billets for re-rolling will be sourced from main steel producers only shall be furnished with regards to re-roller.</p> <p>For Module Mounting Structures, sources of steel other than those specified under this Clause may also be used subject to the condition that they otherwise meet the requirements of the Technical Specifications / Bid Documents.</p> <p>Even after clearance of re-rollers, induction of billets with identified and correlated Mill test certificates (TC's) in the process of re-rolling, sampling of steel, quality checks thereof and stamping of final product for further identification and correlation with TC's prior to dispatch shall be the responsibility of the contractor and these shall be performed in presence of the authorized representative of the main Contractor.</p> <p>Reinforcement steel shall be procured from main steel producers like SAIL, TISCO, RINL, Essar Steel, Ispat Industries, JSW Steel, Lloyds Steel Industries, Jindal Steel & Power and Jai Balaji Industries Ltd, Durgapur (for 8-40mm reinforcement steel) and mill test certificates (TC) is to be obtained and submitted to NTPC for co-relation.</p> <p>The other conditions are covered in the chapter 'GTR'.</p>			
6.	<p>FIELD QUALITY PLAN</p> <p>Well before the start of the work, the contractor shall prepare and submit the Field Quality Plans (FQP) on the format No. QS-01-QAI-P-09/F2-R1, and obtain approval of NTPC, which shall detail out for all the works, equipments, services,</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9	PART-F	Page 348 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
7.	<p>quality practices and procedures etc in line with the requirement of the technical specifications to be followed by the contractor at site. This FQP shall cover for all the items / activities covered in the contract / schedule of items required, right from material procurement to completion of the work at site. An Indicative Field Quality Plan for civil works is enclosed at Annexure – II (Indicative FQP for civil works).</p>			
	<p>GENERAL QA REQUIREMENTS</p> <p>The contractor shall ensure that the works, BOIs and services under the scope of contract whether manufactured or performed within contractor's works or at his sub-contractor's premises or at the NTPC's site or at any other place of work are in accordance with the NTPC technical specification, applicable standards / codes, approved drawings / data sheets / quality plans and BOQ. All the works, BOIs and services shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer.</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004 (R)-9	PART-F	Page 349 of 415

CLAUSE NO.	<div>एनटीपीसी NTPC</div> <div>TECHNICAL SPECIFICATIONS</div>																																																					
	<div>ANNEXURE - I</div> <div>TYPICAL QA/QC LAB EQUIPMENT</div> <table><tr><th>S.No</th><th>Equipment</th><th>Approximate Nos.</th></tr><tr><td>1.</td><td>Cube Moulds for cement testing</td><td>12</td></tr><tr><td>2.</td><td>Sieve shaker</td><td>1</td></tr><tr><td>3.</td><td>Sieves for sand, coarse & fine aggregate</td><td>1 set for each</td></tr><tr><td>4.</td><td>Sieves for coarse aggregate</td><td>1 set</td></tr><tr><td>5.</td><td>Slump testing equipment</td><td>6 sets</td></tr><tr><td>6.</td><td>Oven</td><td>2</td></tr><tr><td>7.</td><td>Physical balance</td><td>1</td></tr><tr><td>8.</td><td>Thermometer</td><td>4</td></tr><tr><td>9.</td><td>Burret</td><td>2</td></tr><tr><td>10.</td><td>Measuring cylinders</td><td>9</td></tr><tr><td>11.</td><td>Measuring flasks</td><td>3</td></tr><tr><td>12.</td><td>Compression testing machine</td><td>1 set</td></tr><tr><td>13.</td><td>Cube moulds for Concrete</td><td>18</td></tr><tr><td>14.</td><td>Mechanical weighing machine</td><td>1 (100 kg capacity)</td></tr><tr><td>15.</td><td>Drum Type Concrete Mixer (for trial mixes)</td><td>1</td></tr><tr><td>16.</td><td>Proctor Testing Equipment</td><td>1 set</td></tr></table> <div>Note :<ol style="list-style-type: none">The equipments listed above are indicative and required to be mobilised as minimum requirement. Additional equipment if any, required for successful completion of work shall be provided /arranged by the contractor.All test reports/ inspection reports have to be computerized and maintained on LAN with an access to the ownerBased on the schedule (L2/L3 Network), Quality control & Quality Assurance work plan shall be finalized by the contractor and the same shall be submitted to the engineer-in-charge for acceptance/approval. The Finalized work plan shall be maintained on the computer to be accessed by the owner for database and day to day monitoring.</div>			S.No	Equipment	Approximate Nos.	1.	Cube Moulds for cement testing	12	2.	Sieve shaker	1	3.	Sieves for sand, coarse & fine aggregate	1 set for each	4.	Sieves for coarse aggregate	1 set	5.	Slump testing equipment	6 sets	6.	Oven	2	7.	Physical balance	1	8.	Thermometer	4	9.	Burret	2	10.	Measuring cylinders	9	11.	Measuring flasks	3	12.	Compression testing machine	1 set	13.	Cube moulds for Concrete	18	14.	Mechanical weighing machine	1 (100 kg capacity)	15.	Drum Type Concrete Mixer (for trial mixes)	1	16.	Proctor Testing Equipment	1 set
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Page 350 of 415																																																						

CLAUSE NO.		TECHNICAL SPECIFICATIONS												<div>एनटीपीसी NTPC</div>	
FQP FOR CIVIL WORKS															
INDICATIVE FIELD QUALITY PLAN															
ITEM : CIVIL WORK		OP NO. : 1		PROJECT: SOLAR PV PROJECT		PACKAGE: XXXX-VVY		CONTRACT NO. XXXX-VVY		MAIN CONTRACTOR		Reference Document			
SUB-SYSTEM : CIVIL AND STRUCTURAL STEEL WORKS		DATE : Page 1 of 11		Quantum Of check		Type of Check		Class of check		Acceptance Norms		Format of Record			
SI. No		Activity and operation		Characteristics / Instruments		3		4		5		6			
1		2		3		4		5		6		7			
1		GENERAL REQUIREMENTS													
A		Availability of QA& QC manpower and laboratory						A		Physical		Once prior to start of work and thereof monthly			
B		Sampling for testing of building materials, concrete mix design etc.		As agreed / required				A		Physical		As specified in FQP for various materials			
C		Submission of schedule of tests to be done monthly / quarterly						A		Physical		Once prior to start of work and thereof monthly			
D		Stacking and storage of construction materials and components at site		As per IS 4082				A		Physical		Tech Specs and Const. Drawings and IS 4082			
2		EXCAVATION AND FILLING IN FOUNDATION WORKS													
2.1		Excavations-													
2.2		Nature, type of soil/rock before and during excavations		As agreed / required				C		Visual		Random in each shift			
2.3		Initial ground level before start of excavations		As agreed / required				C		Measurement		100%			
2.4		Final shape and Dimensions of excavations		As agreed / required				C		Measurement		100%			
2.5		Final excavation levels		As agreed / required				B		Measurement		100%			
2.6		Side slope of final excavation		As agreed / required				B		Measurement		Random in each shift			
2.7		Fill/ Backfill -													
2.8		Standard proctor Test		As per IS : 2720; Proctor, needle apparatus etc.				B		Physical		One in every 2000 cum for each type and source of fill materials			
2.9		Moisture content		As per IS : 2720; balance, oven, rapid moisture meter, etc.				B		Physical		One in every 2000 cum for each type and source of fill materials			
2.10		Degree Of Compaction Of Fill / Backfill													
1		Dry density by core cutter method		As per IS: 2720/compaction test (core cutter), balance, rapid moisture meter etc.				A		Physical		One sample for every 2000 SQM area for each compacted layer			
2		OR----													
3		Dry density in place by sand displacement method													
3.0		MATERIALS													
3.1		CEMENT													
		Retesting of cement		as per IS 4031				A		Testing		At Random			
3.2		Coarse Aggregate						B		Physical		Once for each stack of 100 Cum. or part there of			
ii		Specific gravity, water absorption		IS 2386				A		Physical		Once for each source & for every change of source			

CLAUSE NO.

TECHNICAL SPECIFICATIONS



INDICATIVE FIELD QUALITY PLAN									
ITEM : CIVIL WORK		QF NO. : 1		1		PROJECT: SOLAR PV PROJECT			
SUB-SYSTEM : CIVIL AND STRUCTURAL STEEL WORKS		REV. NO. : 1		1		PACKAGE: XXXX-YYY			
		PAGE : 2 of 11		1		MAIN CONTRACTOR			
		DATE : 2024-07-11		1		Reference Document			
		Class of check		Type of Check		Quantum Of check			
		3		5		6			
		Characteristics / Instruments		Physical		One per 100 cum, or part thereof			
				Physical		Once per source/ on every change of source			
				Physical		-do-			
				Physical		-do-			
				Physical		To be done every day/ before start of work			
				Physical		Once per source& for on every change of source			
				Physical		IS-2386, IS-383			
				Testing		IS-3025 part 22 and 23 (for test procedure), IS-456(for acceptance criteria)			
				Physical		One set of 6 cubes per 50 Cum or part thereof for each grade of concrete per shift whichever is earlier.			
				Physical		At the time of concrete pouring at site every two hrs			
				Review of MTC		For each lot received at site			
				Visual		100%			
				Physical		100%			
				Physical		100%			
				Measurement		Approved Drawing			
				Measurement		As per IS-456/ tech. Specification.			
				Measurement		As per IS-456/ tech. Specification.			
				Measurement		As per IS-456/ tech. Specification.			
				Measurement		As per IS-456/ tech. Specification.			
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				Measurement		As per IS-456/ tech. Specification.			
				Measurement		As per IS-456/ tech. Specification.			
				Measurement		As per IS-4			

INDICATIVE FIELD QUALITY PLAN									
ITEM : CIVIL WORK		QP NO. 1		1		PROJECT: SOLAR PV PROJECT			
SUB-SYSTEM : CIVIL AND STRUCTURAL STEEL WORKS		REV NO. 1		1		PACKAGE: MAIN CONTRACTOR		XXXX-YYY	
PAGE : 1		DATE :		Page 3 of 11		Reference Document		Remarks	
Characteristics / Instruments		Type of Check		Quantum Of check		Acceptance Norms		Format of Record	
3		5		6		7		8	
4		5		6		7		8	
3		5		6		7		8	
1	2	Water Tightness Test of liquid retaining structure/ tanks	As required	B	Test	100%	IS 3370 Tech. Specification	SR-1/B	✓
3.9 REINFORCEMENT STEEL									
		Physical and Chemical Properties for each lot as per relevant IS codes	As required/ agreed	A	Review of MTC	Each batch of delivery	IS : 1786, IS 432, IS 1686, Tech Specs and Const. Drawings	MTC	✓
		Freedom from cracks surface flamm. Lamination.	As agreed / required	C	Visual	Random in each shift	IS : 1692, IS 432, IS 1786, Tech Specs and Const. Drawings	SR	✓
3.9 PLACEMENT OF REINFORCEMENT STEEL									
		Bar bending schedule with necessary fix. Spacers & Chairs	As agreed / required	B	Visual & Measurement	Random in each shift	Approved Drawings, Tech Specs and Const. Drawings IS 2502	SR	✓
		Bending of bars, cutting tolerance	As agreed / required	C	Visual & Measurement	Random in each shift	Approved Drawings, Tech Specs and Const. Drawings IS 2502.	SR	✓
		Acceptance – Cover, spacing of bars, spacers and chairs after the reinforcement cage is put inside the formwork	As agreed / required	B	Visual & Measurement	Random in each shift	Approved Drawings, Tech Specs and Const. Drawings	SR	✓
3.10 STAGING AND FORMS									
		Materials and accessories	As agreed / required	C	Visual	Once before start of work	As per relevant IS, Tech Specs and Const. Drawings	SR	✓
		Soundness of staging, shuffling and scaffolding including application of mould oil / release agent	As agreed / required	C	Visual	Once before start of work	As per manufacturer's spec and as per IS 3000 4014, 4360, Tech Specs and Const. Drawings	SR	✓
		Acceptance of formwork before start of concreting		B	Physical / Visual	Before start of each concreting	As per employee and supervision, Tech Specs and Const. Drawings	SR	✓
3.11 DAMP PROOF COURSE									
		Material – Hot bitumen and water proofing materials etc.	As agreed / required	B	Review of MTC	Each batch of delivery at site	Tech Specs and Const. Drawings IS 702	SR	✓
		Acceptance of damp proof course	As agreed / required	B	Acceptance	100%	Tech Specs and Const. Drawings	SR	✓
3.12 GROUTING									
		Material	As agreed / required	B	Review of MTC	Each batch of delivery	Tech Specs and Const. Drawings	SR	✓
		Type of mix – fluid mix, plastic mix, stiff mix etc.	As agreed / required	C	Physical	Prior to start of work	Tech Specs and Const. Drawings	SR	✓
		Mixing, placement, application and grout pressure	As agreed / required	C	Physical	Random in each shift	Tech Specs and Const. Drawings	SR	✓
		Compressive strength	As agreed / required	C	Physical	Random in each shift	Tech Specs and Const. Drawings	SR	✓
		Acceptance of the grouts	As agreed / required	B	Physical	Each grout section.	Tech Specs and Const. Drawings	SR	✓
4.00 BRICK MASONRY									
4.1 Tie on Bricks									
		Dimensions, shape, compressive strength, water absorption, modulus of rupture	As agreed / required	B	Measurement / Physical Test	As per relevant IS Code / One Sample for 20,000 nos. of partition wall	IS : 1907, IS 15757, IS : 15654 / Tech Specs and Const. Drawings	Inspected on site Report	✓
4.2 Masonry construction									
5.00 FINISHING AND ALLIED WORKS									
		Workmanship, verticality and alignment	As agreed / required	B	Visual / Physical	100%	IS 2312, IS 1905, Tech Specs and Const. Drawings	SR-1/B	✓
Efficiency shall be checked at each source									

CLAUSE NO.

TECHNICAL SPECIFICATIONS



INDICATIVE FIELD QUALITY PLAN									
Sl. No	Activity and operation	ITEM : CIVIL WORK	QF NO. :	1	PROJECT :	SOLAR PV PROJECT	CONTRACT NO.	XXXX-YYY	Remarks
		SUB-SYSTEM : CIVIL AND STRUCTURAL STEEL WORKS	REV. NO. :	1	PACKAGE :		MAIN CONTRACTOR		
			DATE :	Page 4 of 11	Reference Document	Acceptance	Format of		
		Characteristics / Instruments	Class of check	5	Quantum Of check	8	Record		
1	2	3	4	5	6	7	9	D*	10
i	Curing	As agreed / required	C	Physical	100%	Tech specifications, construction drawings and agreed methodology	SR		
ii	Thickness and finishing of plaster, grooves etc.	As agreed / required	B	Visual/ Measurement	Random in each shift	Tech Specs and Const. Drawings	SR/LB		
iii	Thickness of plastering system	As agreed / required	B	Visual/Physical	Random in each shift	Tech Specs and Const. Drawings	SR		
6.2	STONE GRIT PLASTER/GRANULAR TEXTURED COAT FINISH								
i	Material	As agreed / required	B	Review of MTC	For each lot received at site	Tech Specs and Const. Drawings	SR	✓	
ii	Thickness, finishing and grooves etc.	As agreed / required	C	Visual/ Measurement	Random in each shift	Tech Specs and Const. Drawings	SR	✓	
6.00	SHEETING AND OTHER WORKS								
6.1	PAINTING SYSTEM - CONCRETE WORKS AND PLASTERED MASONRY SURFACES								
i	Materials and accessories- Oil Bound Acrylic Emulsion, Chemical Resistant, Oil Resistant Paint etc.	As agreed / required	B	Review of MTC	Each batch of delivery	Tech Specs and Const. Drawings	SR/MTC	✓	
ii	Surface preparation	As required	C	Physical / Visual	Random in each shift	Tech Specs and Const. Drawings	SR		
iii	Acceptance of painted surfaces	As required	B	Physical	Each surface at random	Tech Specs and Const. Drawings	SR		
6.1.1	PAINTING SYSTEM - STEEL WORKS (OTHER THAN STRUCTURAL STEEL WORKS)								
i	Painting Materials and accessories	-	B	Review of MTC	Each batch of delivery	Tech Specs and Const. Drawings	SR/MTC	✓	
ii	Surface preparation	As agreed / required	C	Physical / Visual	Each Erection Mark	Tech Specs and Const. Drawings, Relevant code/ standards	SR	✓	
iii	Primer Thickness	Elcometer	C	Measurement	Each Erection Mark	Tech Specs and Const. Drawings	SR	✓	
iv	DFT of paint	Elcometer	C	Measurement	Each Erection Mark	Tech Specs and Const. Drawings	SR	✓	
v	Acceptance of painted surfaces	Elcometer	B	Visual and measurement	Each Erection Mark	Tech Specs and Const. Drawings	SR		
6.2	INSULATION WORKS								
i	Material	Insulation material, galvanised wire net, aluminium foil, fasteners.	B	Review of MTC	For each lot received at site	Tech Specs and Const. Drawings	SR / LB	✓	
ii	Acceptance of each type of installation	As agreed / required	B	Visual/Physical	Each installation	Tech Specs and Const. Drawings	SR/LB		
7.00	DOORS, WINDOWS VENTILATORS & GRILL								
7.1	Fire proof doors								
i	Source of supply		A	Review of purchase order (unpriced copy) / drawings of suppliers / certificate of CBRI	For each source	Tech Specs and Const. Drawings	SR	✓	Procured from Approved parties as per relevant IS/Tech. The door drawing proposed for supply should have been tested and approved by CBRI Roorkee for the similar dimensions for minimum 2 hours fire rating.
ii	Receipt inspection	As agreed / required	B	Visual/Physical/ Review of MTC	For each lot received at site	Tech Specs and Const. Drawings	SR	✓	
iii	Finishing and acceptance	As agreed / required	B	Visual / physical	Random	Tech Specs and Const. Drawings	SR		
7.2	False Ceiling								
i	Materials (gypsum glass fibre membrane, fire board acoustical tiles etc)	As agreed / required	B	Review of MTC	For each lot received at site	Tech Specs and Const. Drawings	SR	✓	Compare MTC with technical specification and requirement
ii	Installation finishing and acceptance	As agreed / required	B	Visual / physical	Random	Tech Specs and Const. Drawings	SR		
7.3	WATER PROOFING								

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DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAGE PROJECT(S) IN MADHYA PRADESH

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INDICATIVE FIELD QUALITY PLAN									
Sl. No	Activity and operation	ITEM : CIVIL WORK	QF NO. :		PROJECT :		SOLAR PV PROJECT		
			REV. NO. :	DATE :	PACKAGE :	CONTRACT NO.	XXXX-YYY		
			PAGE :	CLASS :	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD
			check	check	check	check	check	check	check
1	2	3	4	5	6	7	8	9	10
8.0 WATER SUPPLY / SANITARY INSTALLATIONS									
8.1 Water supply fittings and fixtures									
I	Materials	G/MS pipes and fittings	As agreed / required	Review of MTC	Each lot of delivery as per Specifications	Tech Specs and Const. Drawings	SR	SR	✓
II	Disinfection	Before use	As agreed / required	Physical	Each installation	Tech Specs and Const. Drawings	SR	SR	✓
III	Hydraulic test	Before use / leakage	As agreed / required	Physical	Each installation	Tech Specs and Const. Drawings	SR	SR	✓
IV	Acceptance and working	As agreed / required	As agreed / required	Acceptance	Random	Tech Specs and Const. Drawings	SR	SR	✓
8.2 Sand cast iron / cast iron pipes									
I	Material	SCI / CI pipes and fittings / joints	As agreed / required	Review of MTC	Each lot of delivery as per Specifications	Tech Specs and Const. Drawings	SR	SR	✓
II		Acceptance and leakage	As agreed / required	Physical	Random	Tech Specs and Const. Drawings	SR	SR	✓
8.3 Sanitary fittings and fixtures									
I	Material	Sanitary items and fixtures i.e water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap containers, geyser, water cooler, etc, water supply / sanitation pipes, manhole cover and frames, etc	As agreed / required	Physical	Each lot of delivery as per Specifications	Tech Specs and Const. Drawings	SR	SR	✓
II		Acceptance of installations of all sanitary items and fixtures	As agreed / required	Acceptance	100%	Tech Specs and Const. Drawings	SR	SR	✓
8.4 RCC Pipes									
I	Material	RCC pipes	As agreed / required	Review of MTC	Each lot of delivery as per Specifications	Tech Specs and Const. Drawings / IS 458	SR	SR	✓
II		Acceptance and leakage	As agreed / required	Physical	Random	Tech Specs and Const. Drawings	SR	SR	✓
8.5 Water Storage Tanks									
I	Material	Over head / lot type	As agreed / required	Physical	Each lot of delivery as per Specifications	Tech Specs and Const. Drawings	SR	SR	✓
II		Acceptance and leakage	As agreed / required	Acceptance	Random	Tech Specs and Const. Drawings	SR	SR	✓
9.0 SPECIAL ITEMS									
9.1 Earthing Mat (Grounding System)									
I	Material	Earthing mat	As agreed / required	Physical	Each lot of delivery as per Specifications	As per relevant IS and Tech. Specs / Manufacturers, IS 3043	SR/MTC	SR/MTC	✓
II		Weld sizes & length	Visual/Tape	Visual/ Measurement	100%	Tech Specs and Const. Drawings	TR	TR	✓
III		D.P test	DP test kit	Physical	10% at random of the offered lot	Tech Specs and Const. Drawings	TR	TR	✓
IV		Earth test	Earthing test kit	Physical	100%	Tech Specs and Const. Drawings	SR	SR	✓
10.00 STRUCTURAL STEEL MATERIAL (For Site Fabrication)									
I	Structural steel procured from NTPC approved sources- Mechanical (YS, UTS, Elg, UT if specified), and Chemical properties (CE as per IS)		A	Review	For each batch of each section delivered at site	Technical Specification and Construction Drawings, IS 2002, 8500	SR	SR	✓
10.1 PRE-WELDING REQUIREMENTS									
I	Welding Procedure Specification * (WPS)	-	A	Review	Each Welding Process	Technical Specification and Construction Drawings, ASME-IX/AWS D 1.1	WPS	WPS	✓
II	Welding consumables	-	A	Physical	Each welder	Approved WPS, Latest NTPC	TR	TR	✓
III			B	Physical	Random in each shift		SR	SR	✓

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DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH

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Sl. No	Activity and operation	ITEM : CIVIL WORK	QF NO. :		PROJECT :		SOLAR PV PROJECT		
			REV. NO. :	DATE :	PACKAGE :	CONTRACT NO.	XXXX-YYY		
			PAGE :	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	REMARKS
1	2	3	4	5	6	7	8	9	10
10.2	10.2.1	10.2.1.1	10.2.1.1.1	10.2.1.1.1.1	10.2.1.1.1.1.1	10.2.1.1.1.1.1.1	10.2.1.1.1.1.1.1.1	10.2.1.1.1.1.1.1.1.1	10.2.1.1.1.1.1.1.1.1.1
i	Marking and Cutting	Tape, ruler etc	B	Visual & Measurement	Each plate/ Section	SR	Technical Specification and Construction Drawings, Approved cutting plan	SR	
ii	Match markings for trial assembled components	-	B	Physical	Each fit-up	SR	Technical Specification and Construction Drawings	SR	
iii	Weld Fit Up- Edge Preparation/ Gap/ Alignment	Tape, ruler etc	B	Physical	Each fit-up	SR	Technical Specification and Construction Drawings, IS 7215	SR	If required suitable stiffeners shall be provided to prevent deflection.
10.3	10.3.1	10.3.1.1	10.3.1.1.1	10.3.1.1.1.1	10.3.1.1.1.1.1	10.3.1.1.1.1.1.1	10.3.1.1.1.1.1.1.1	10.3.1.1.1.1.1.1.1.1	10.3.1.1.1.1.1.1.1.1
i	PRE HEATING (wherever applicable)	Pre-Heating Temperature	B	Measurement	Each pre-heating	SR	Technical Specification and Construction Drawings, Approved WPS	SR	
ii	Post Weld Heat Treatment (PWHT), if required	Thermo couple with time temperature recorder	A	Time & Temperature	Each PWHT	SR	Technical Specification and Construction Drawings, Approved WPS	SR	
10.4	10.4.1	10.4.1.1	10.4.1.1.1	10.4.1.1.1.1	10.4.1.1.1.1.1	10.4.1.1.1.1.1.1	10.4.1.1.1.1.1.1.1	10.4.1.1.1.1.1.1.1.1	10.4.1.1.1.1.1.1.1.1
i	Sequence of welding	-	B	Physical	Random in each shift	SR	Technical Specification and Construction Drawings, Agreed scheme	SR	
ii	Removal/ grinding of temporary attachments	-	B	Measurement	All cleats/ attachments	SR	Technical Specification and Construction Drawings, Approved Drg	SR	
iii	Completeness after welding- Dimensions/ distortion	Weld gauge	B	Visual	Each structure component	SR	Technical Specification and Construction Drawings, IS 822	SR	
iv	Completeness of welding (each butt & fillet weld)	-	B	Visual	Each structure component	SR	Technical Specification and Construction Drawings, Approved Drg	SR	
10.50	10.50.1	10.50.1.1	10.50.1.1.1	10.50.1.1.1.1	10.50.1.1.1.1.1	10.50.1.1.1.1.1.1	10.50.1.1.1.1.1.1.1	10.50.1.1.1.1.1.1.1.1	10.50.1.1.1.1.1.1.1.1
i	NON DESTRUCTIVE AND DESTRUCTIVE TESTING	size and visual examination	B	Visual/ Measurement	100%	SR	As per technical specifications and construction drawings, IS 822, AWS D 1.1	SR	As per requirement of NTPC Engineer
ii	Dye Penetration Test	As required/ agreed	B	Physical	5% of Weld length with min. 300mm at each location	SR	As per technical specifications and construction drawings, IS 822, AWS D 1.1	SR	
10.5.2	10.5.2.1	10.5.2.1.1	10.5.2.1.1.1	10.5.2.1.1.1.1	10.5.2.1.1.1.1.1	10.5.2.1.1.1.1.1.1	10.5.2.1.1.1.1.1.1.1	10.5.2.1.1.1.1.1.1.1.1	10.5.2.1.1.1.1.1.1.1.1
i	Visual examination	As required/ agreed	B	Visual	Random in each shift	SR	As per technical specifications and construction drawings, IS 822, AWS D 1.1	SR	As per requirement of NTPC Engineer
ii	DFT	As required/ agreed	B	Physical	100% on all butt welds after back gouging on root run and 10% on	IR	As per technical specifications and construction drawings, IS 822, AWS D 1.1	IR	All butt welds to be back gouged before DFT
iii	Radiography Test	As required/ agreed	A	Physical	10%	IR	As per technical specifications and construction drawings, IS 822, AWS D 1.1	IR	Wherever RT is not feasible UT to be carried out. In case of failure of any welds in SPOT RT or UT the % of retesting shall be doubled at that particular location. Acceptance criteria of NDT on welds shall be as per AWS D1.1.
10.60	10.60.1	10.60.1.1	10.60.1.1.1	10.60.1.1.1.1	10.60.1.1.1.1.1	10.60.1.1.1.1.1.1	10.60.1.1.1.1.1.1.1	10.60.1.1.1.1.1.1.1.1	10.60.1.1.1.1.1.1.1.1
i	FOUNDATION CHECKS	Dimensions and levels, Shape, lines (including diagonal checks)	B	Physical/ Measurement	Each Foundation	SR	Tech Specs and Const. Drawings	SR	
ii	Foundation Bolts and Embedments- Verticality, Levels, pitch distance	Theodolite, Tape, Plano wires etc	B	Physical/ Measurement	Each Foundation	SR	Tech Specs and Const. Drawings	SR	
10.70	10.70.1	10.70.1.1	10.70.1.1.1	10.70.1.1.1.1	10.70.1.1.1.1.1	10.70.1.1.1.1.1.1	10.70.1.1.1.1.1.1.1	10.70.1.1.1.1.1.1.1.1	10.70.1.1.1.1.1.1.1.1
i	Painting Materials and accessories	-	A	Review of MTC	Each batch of delivery	SR/MTC	Tech Specs and Const. Drawings	SR/MTC	IMF's T.C. shall be correlated with the consent received.
ii	Submission of painting methodology	-	B	For Review of painting system	Before start of painting work		Tech Specs and Const. Drawings		
iii	Surface preparation	As agreed/ required	B	Physical/ Visual	Each Erection Mark	SR	Tech Specs and Const. Drawings.	SR	

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DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH

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INDICATIVE FIELD QUALITY PLAN									
Sl. No	Activity and operation	ITEM : CIVIL WORK	QF NO. :		1	PROJECT :		SOLAR PV PROJECT	
			REV. NO. :	DATE :		PACKAGE :	CONTRACT NO.	XXXX-YYY	
1	2	3	4	5	6	7	8	9	10
iv	v	vi	vii	viii	ix	x	xi	xii	xiii
10.80	PRE-ASSEMBLY CHECKS	Characteristics / Instruments	Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	Remarks
i	Primer Thickness	Elcometer	B	Measurement	Each Erection Mark	Tech Specs and Const. Drawings	SR	SR	✓
ii	DFT of paint	Elcometer	B	Measurement	Each Erection Mark	Tech Specs and Const. Drawings	SR	SR	✓
iii	Acceptance of painted surfaces	Elcometer	B	Visual and measurement	Each Erection Mark	Tech Specs and Const. Drawings	SR	SR	✓
iv	Punch Erection marks and match marks on members	-	B	Visual/Physical	Each structural member	Tech Specs and Const. Drawings			Markings for - Assembly designation, Part number, Weight, Any other important
v	Pre-assembly as per match mark	-	B	Visual/Physical	Each structural member	Tech Specs and Const. Drawings			
vi	Camber, sweep and total length after trial assembly of structure.	Theodolite, Tape, plumb, piano wires etc	B	Visual/Physical	Each structural member	Tech Specs and Const. Drawings	SR	SR	✓
vii	Control assembly check at shop	Theodolite, Tape, plumb, piano wires etc	B	Visual/Physical	Every first and tenth set of identical structure	Tech Specs and Const. Drawings			
viii	Completion of primer & intermediate coat of paint	-	B	Visual / Physical	Random	Tech Specs and Const. Drawings	SR	SR	
ix	Alignment, slopes, level, tolerances of erected member	Theodolite, Tape, plumb, piano wires etc	B	Measurement	Each structural member	Tech Specs and Const. Drawings	SR	SR	✓
x	Tightening of bolts/ Torque including foundation bolts with lock nuts	Wrench/ Torque wrench if specified	B	Visual/Physical	Each structural member	Tech Specs and Const. Drawings	SR	SR	✓
xi	Completion of all erection fillet & butt welds	-	B	Visual	Each structural member	Tech Specs and Const. Drawings	SR	SR	✓
xii	Acceptance of erected structure	Theodolite, Tape, plumb, piano wires etc	B	Visual/Physical	Each erected structure	Tech Specs and Const. Drawings, IS 7215 and IS 12843	SR	SR	✓
10.10	PERMANENT BOLTS AND NUTS AND WASHERS								
i	Material- Permanent mild steel Bolts, mild steel Nuts, High strength structural Bolts, Washers-Dimensions, properties, Class, storage along with MTC	Screw gauge, Vernier, Tape etc.	A	Physical and MTC Review	Once for each lot of delivery	Tech Specs and Const. Drawings	SR/MTC	✓	
ii	Contact surfaces before bolting	-	B	Physical	Random before assembly for bolting	Tech Specs and Const. Drawings, IS 4000	SR	SR	
iii	Inspection of the assembled bolts	-	B	Physical	Randomly in each shift for assembled bolts	Tech Specs and Const. Drawings, IS 4000	SR	SR	
iv	Tensioning	As agreed / required	B	Physical	Randomly during snug tight test and after full tensioning	Tech Specs and Const. Drawings, IS 4000	SR	SR	✓
v	Acceptance of installed bolts	-	B	Physical	Each bolt	Tech Specs and Const. Drawings	SR	SR	
11.0	ROAD WORKS								
11.1	Construction of Sub-Grade and earthen/hard soulders								
i	Standard proctor Test		B	Physical	One in every 2000 cum for each type and source of fill materials	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification, IS 2720 (Pt. VII)	SR/TR	✓	In cutting or existing levelled ground - quantum of check shall be one per 1000 SQM
ii	Moisture content of fill before compaction		B	Physical	One in every 2000 cum for each type and source of fill materials	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification, IS 2720 (Pt. II)	SR/TR		In cutting or existing levelled ground - quantum of check shall be one per 1000 SQM
iii	Dry density by core cutter method OR Dry density in place by sand displacement method		A	Physical	One in every 500 SQM area for each compacted layer	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification, IS 2720 (Pt. XXIX/ IS 2720 (Pt. XXVIII),	SR/TR	✓	Both for embankment and cut formation quantum of check - One in every 1000 SQM area for each compacted layer
iv	Lines, grade and cross section	As required / agreed	B	Physical	One in every 500 SQM area	As per Tech Specs and Const. Drawings	SR		Template, straight edge
11.2	Water Bound Macadam (Non-Bituminous) for base course and sub-base course								


INDICATIVE FIELD QUALITY PLAN											
ITEM : CIVIL WORK		GP NO. : REV NO. : DATE :			1 1		PROJECT: PACKAGE: CONTRACT NO.		SOLAR PV PROJECT XXXX-YYY		
SUB-SYSTEM : CIVIL AND STRUCTURAL STEEL WORKS		PAGE : Page 8 of 11			MAIN CONTRACTOR						
Sl. No	Activity and operation	Characteristics / Instruments			Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	Remarks
		3	4	5							
i	Aggregate Impact value		Aggregate Impact value Test Apparatus	B	Physical	One test per 200 cum of Test aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification,	SR	✓		
ii	Grading		Set of IS Sieves	B	Physical	One test per 100 cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification,	SR			
iii	Flakiness index and elongation index		Flakiness test gauge	B	Physical	One test per 200cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification,	SR			
iv	Atterberg Limits of binding material		Atterberg limits determination	B	Physical	One test per 25 cum of binding material	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification,	SR	✓		
v	Atterberg Limits of portion of aggregate passing 425 micron sieve		Atterberg limits determination	B	Physical	One test per 100cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification,	SR	✓		
vi	Camber, surface, slope		As required / agreed	B	Physical	One in every 500 SQM area	As per Tech Specs and Const. Drawings	SR		Template, straight edge	
11.3 Bituminous Macadam for base and binder course											
i	Quality of binder		Penetrometer with St. needle	B	Physical	No. of samples per Lot & tests as per IS 73, IS 217, IS 8887 as applicable	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification	SR	✓		
ii	Aggregate Impact Value / Los angeles abrasion value		Aggregate Impact Value test apparatus	A	Physical	Once per source	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification	SR	✓		
iii	Flakiness Index and elongation index of aggregates		Flakiness test gauge	B	Physical	One test per 50 cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification	SR			
iv	Stripping value of aggregate (Immersion tray test)		As required / agreed	B	Physical	Initially one set of 3 representative specimen per source, and on every change of source.	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification	SR			
v	Water sensitivity of mix		As required / agreed	B	Physical	Initially one set of 3 representative specimen per source, and on every change of source.	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification	SR	✓		
vi	Grading of aggregates		Set of Sieves	B	Physical	Two test per day per plant both on individual constituents and mixed aggregate from dryer	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification	SR			
vii	Water absorption of aggregate		As required / agreed			Initially one set of 3 representative specimen per source, and on every change of source.	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification	SR			
viii	Soundness (Magnesium and Sodium Sulphate)		As required as per IS 2386	A	Physical	Once per source by each method and on every change of source	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification	SR	✓		
ix	Percentage of fractured faces		As required / agreed	B	Physical	When gravel is used one test per 50cum of aggregates	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification	SR			
x	Binder content and aggregate grading		As required / agreed	A	Physical	Periodic, subject to a min of two tests per day	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification	SR	✓		
xi	Control of Temperature of binder and aggregate for mixing and of the mix at		Bitumen extractor Thermometer	B	Physical	At regular close intervals per plant	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification	SR			

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ITEM : CIVIL WORK		QF NO. : 1		PROJECT: SOLAR PV PROJECT						
SUB-SYSTEM : CIVIL AND STRUCTURAL STEEL WORKS		REV NO. : 1		PACKAGE: XXXX-YYY						
PAGE : 1		DATE : 11/11/2024		MAIN CONTRACTOR						
Sl. No	Activity and operation	Characteristics / Instruments		Quantum Of check	Acceptance Norms	Format of Record	Remarks			
		Class of check	Type of Check	7	8	D*				
i	Rate of spread of mixed materials	B	Physical	Regular control through checks of layer thickness	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
ii	Density of compacted Layer	A	Physical	One test per 250 sqm of area	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
11.4 Bituminous Surfacing – Open graded premix carpet and Seal coat										
i	Quality of binder	A	Physical	No. of samples per Lot & tests as per IS 73, IS 217, IS 8887 as applicable	IS 73, Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
ii	Aggregate Impact Value / Los Angeles Value/ test apparatus	B	Physical	One test per 50 cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
iii	Flakiness Index and elongation index/of aggregates	B	Physical	One test per 50 cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
iv	Stripping value of aggregate (Immersion tray test)	B	Physical	Initially one set of 3 representative specimen per source, and on every change of source	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
v	Water absorption test	B	Physical	Initially one set of 3 representative specimen per source, and on every change of source	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
vi	Water sensitivity of mix	B	Physical	Initially one set of 3 representative specimen per source, and on every change of source	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
vii	Grading of aggregates	B	Physical	One test per 25 cum of aggregates	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
viii	Soundness (Magnesium and Sodium Sulphate)	A	Physical	Once per source by each method and on every change of source	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
ix	Polished stone value	B	Physical	As required	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
x	Temperature of binder at application	B	Physical	At regular close intervals	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
xi	Binder content	A	Physical	One test per 500 cum& not less than two tests per day	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
xii	Rate of spread of materials	B	Physical	One test per 500 cum and not less than 2 tests per day	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
xiii	Percentage of fractured faces	B	Physical	When gravel is used one test per 50cum of aggregates	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
11.5 Tack Coat/ Prime coat/ fog coat										
i	Quality of binder	A	Physical	No. of samples per Lot & tests as per IS 73, IS 217, IS 8887 as applicable	IS 73, Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
ii	Temperature of binder at application	B	Physical	At regular close intervals	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				
iii	Rate of spread of binder	B	Physical	One test per 500 cum and not less than 2 tests	As per Tech Specs and Const. Drawings, Section 900 ofMORTH specification	SR				


CLAUSE NO.	TECHNICAL SPECIFICATIONS																																																																																																																																																																																															
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PART-G GENERAL TECHNICAL REQUIREMENTS


CLAUSE NO.	TECHNICAL SPECIFICATIONS			
1.00.00	INTRODUCTION This part covers technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical requirements brought out in the Technical Specifications and the Technical Data Sheets.			
2.00.00	BRAND NAME Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific item mentioned shall be understood to be indicative of the function and quality desired, and not restrictive; other manufacturer's products may be considered provided sufficient information is furnished to enable the Employer to determine that the products proposed are equivalent to those named.			
3.00.00	BASE OFFER & ALTERNATE PROPOSALS The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognized that the Contractor may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice may also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Employer. Sufficient amount of information for justifying such proposals shall be furnished to Employer along with the bid to enable the Employer to determine the acceptability of these proposals.			
4.00.00	COMPLETENESS OF FACILITIES			
4.01.00	Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure that a completely engineered plant is provided.			
4.02.00	All equipment furnished by the Contractor shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation & maintenance of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
5.00.00	All similar standard components/ parts of similar standard equipment provided, shall be interchangeable with one another.			
5.01.00	CODES & STANDARDS			
5.01.00	<p>In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:</p> <ul style="list-style-type: none">(a) Bureau of Indian Standards (BIS)(b) Indian electricity act(c) Indian electricity rules(d) Indian Explosives Act(e) Indian Factories Act and State Factories Act(f) Indian Boiler Regulations (IBR)(g) Regulations of the Central Pollution Control Board, India(h) Regulations of the Ministry of Environment & Forest (MoEF), Government of India(i) Pollution Control Regulations of Department of Environment, Government of India(j) State Pollution Control Board.(k) Rules for Electrical installation by Tariff Advisory Committee (TAC).(l) Any other statutory codes / standards / regulations, as may be applicable.			
5.02.00	<p>Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:</p> <ul style="list-style-type: none">(a) Japanese Industrial Standards (JIS)(b) American National Standards Institute (ANSI)(c) American Society of Testing and Materials (ASTM)(d) American Society of Mechanical Engineers (ASME)(e) American Petroleum Institute (API)(f) Standards of the Hydraulic Institute, U.S.A.			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	<p>(g) International Organization for Standardization (ISO)</p> <p>(h) Tubular Exchanger Manufacturer's Association (TEMA)</p> <p>(i) American Welding Society (AWS)</p> <p>(j) National Electrical Manufacturers Association (NEMA)</p> <p>(k) National Fire Protection Association (NFPA)</p> <p>(l) International Electro-Technical Commission (IEC)</p> <p>(m)Expansion Joint Manufacturers Association (EJMA)</p> <p>(n) Heat Exchange Institute (HEI)</p>			
5.03.00	Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, alongwith the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.			
5.04.00	As regards highly standardized equipment National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.			
5.05.00	In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.			
5.06.00	Two (2) English language copies of all-national and international codes and/or standards which are not available with NTPC and same is used in the design of the plant, equipment, civil and structural works shall be provided by the Contractor to the Employer within two calendar months from the date of the Notification of Award.			
5.07.00	In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Employer shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	to bring to the notice of the Employer such changes and advise Employer of the resulting effect.			
6.00.00	EQUIPMENT FUNCTIONAL GUARANTEE			
6.01.00	The functional guarantees of the equipment under the scope of the Contract is given elsewhere in the technical specification. These guarantees shall supplement the general functional guarantee provisions covered under General Conditions of Contract.			
6.02.00	Liquidated damages for shortfall in meeting functional guarantee(s) during the performance guarantee tests shall be assessed and recovered from the Contractor as specified elsewhere in this specification.			
7.00.00	DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS			
7.01.00	Design of Facilities			
	All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.			
	The Contractor shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinated performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.			
7.02.00	Maintenance and Availability Considerations			
	Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.			
7.03.00	Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely the minor and major overhauls shall be specified in terms of fired hours, clearly defining the spare parts and man-hour requirement for each stage.			
	Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the contractor for handling of any equipment or any of its part having weight in excess of 500 kgs during erection and maintenance activities.			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
8.00.00	<p>Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the contractor for lifting the equipment and accessories covered under the specification.</p> <p>DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR</p>			
8.01.00	<p>Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.</p>			
8.02.00	<p>The Contractor shall furnish engineering data/drgs. for entire equipment covered under this specification in accordance with the schedule of information as specified in Technical Specification and Data sheets.. This documentation shall include but not be limited to the following :</p>			
8.02.01	<p>INSTRUCTION MANUALS</p> <p>The Contractor shall submit to the Employer, draft Instruction Manuals for all the equipment covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalization and approval of the Employer the Instruction Manuals shall be submitted. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following.</p> <p>(a) Erection & Commissioning Manuals/Checklists</p> <p>The erection & Commissioning Manuals/Checklists shall be submitted atleast three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.</p> <ul style="list-style-type: none">a) Erection strategy.b) Sequence of erection.c) Erection instructions.			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	d) Critical checks and permissible deviation/tolerances.			
	e) List of tool, tackles, heavy equipment like cranes, dozers, etc.			
	f) Bill of Materials			
	g) Procedure for erection.			
	h) General safety procedures to followed during erection/installation.			
	i) Procedure for initial checking after erection.			
	j) Procedure for testing and acceptance norms.			
	k) Procedure / Check list for pre-commissioning activities.			
	l) Procedure / Check list for commissioning of the system.			
	m) Safety precautions to be followed in electrical supply distribution during erection			
	(b) Operation & Maintenance Manuals			
	i. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall be in sufficient detail to enable the Employer to operate, maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant / equipment including, operation, maintenance, dismantling and repair including periodical activities such as chemical cleaning of the generator. Each manual shall also include a complete set of drawings together with performance/rating curves of the equipment and test certificates wherever applicable. The contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied to the Employer.			
ii. If after the commissioning and initial operation of the plant, the manuals require any modification / additions / changes, the same shall be incorporated and the updated final instruction manuals shall be submitted to the Employer for records.				
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
8.02.02	<div><div><div>iii.</div><div>A separate section of the manual shall be for each size/ type of equipment and shall contain a detailed description of construction and operation, together with all relevant pamphlets and drawings.</div></div><div><div>iv.</div><div>The manuals shall include the following :</div><div><div>a)</div><div>List of spare parts along with their drawing and catalogues and procedure for ordering spares.</div></div><div><div>b)</div><div>Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.</div></div><div><div>c)</div><div>Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or break down.</div></div><div><div>v.</div><div>Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc. system/equipment/assembly/sub-assembly - wise required for the complete plant.</div></div><div><div>vi.</div><div>On completion of erection, a complete list of bearings / equipment giving their location, and identification marks etc. shall also be furnished to the Employer indicating lubrication method for each type/category of bearing.</div></div></div></div>			
	<div><div><div>Project Completion Report</div><div>The Contractor shall submit a Project Completion Report at the time of handing over the plant. After final acceptance of individual equipment /system by the Employer, the Contractor will update all original drawings and documents for the equipment/ system to "as built" conditions and submit.</div></div></div>			
	<div><div><div>8.03.00ENGINEERING INFORMATION SUBMISSION SCHEDULE</div><div>Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Employer. For this, the bidder shall furnish a detailed list of engineering information alongwith the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorised into the following parts.</div><div><div>a)</div><div>Information that shall be submitted for the approval of the Employer before proceeding further, and</div></div><div><div>b)</div><div>Information that would be submitted for Employer’s information only.</div></div></div></div>			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
8.04.00	<p>The Engineering Information Schedule shall be updated month-wise.</p> <p>The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.</p> <p>ENGINEERING PROGRESS AND EXCEPTION REPORT</p> <p>Report giving the status of each engineering information including</p> <p>(a) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission</p> <p>(b) Drawings which were not submitted as per agreed schedule.</p> <p>The draft format for this report shall be furnished to the Employer within four (4) weeks of the award of the contract, which shall then be discussed and finalised with the Employer.</p>			
	8.05.00	<p>TECHNICAL CO-ORDINATION MEETING</p> <ul style="list-style-type: none">• The Contractor shall organize and attend at least one monthly progress Meetings with the Employer/Employer's representatives during the period of Contract at mutually agreed venues for review of progress & resolving technical clarifications, if any. The Contractor shall attend such meetings at his own cost and fully co-operate with such persons and agencies involved during the discussions.• The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Contractor shall be equipped with necessary tools and facilities so that, if required, the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.• The Contractor shall furnish monthly progress report to the Employer detailing out the progress achieved on all erection activities as compared to the schedules. This shall be supplemented by printed colour photographs and video in VCD/DVD indicating various stages of erection and the progress of the work done at Site. The report shall also indicate the reasons for the variance between the		
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
8.06.00 				

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
8.09.02	Lubrication Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.			
8.10.00	Material of Construction All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilized for various components shall be those which have established themselves for use in such applications.			
8.11.00	RATING PLATES, NAME PLATES & LABELS			
8.11.01	Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Employer.			
8.11.02	Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back. The name plates shall be suitably fixed on both front and rear sides.			
8.11.03	Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support/hanger.			
8.11.04	Nameplates shall be as per best practices of the industry			
8.11.05	All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.			
8.11.06	All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system			
8.12.00	TOOLS AND TACKLES The Contractor shall supply with the equipment one complete set of all special tools and tackles and other instruments required for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
8.13.00	include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.			
	The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Contractor shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Contractor should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Employer.			
	Welding			
	If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipment to be per formed by others the requirements shall be submitted to the Employer in advance of commencement of erection work.			
	8.14.00 COLOUR CODE FOR ALL EQUIPMENTS/ PIPINGS/ PIPE SERVICES			
8.15.00	All equipment/ piping/ pipe services are to be painted by the Contractor in accordance with Employer’s standard colour coding scheme, which will be furnished to the Contractor during detailed engineering stage.			
8.16.00	PROTECTION AND PRESERVATIVE SHOP COATING			
8.17.00	PROTECTION			
	All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a nonmetallic protection device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or overground environment as the case may be.			
	Preservative Shop Coating			
	All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer.			
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	<p>Transformers and other electrical equipment if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Employer at a later date.</p> <p>Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Employer.</p> <p>All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Employer.</p> <p>All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Employer. Lube oil piping or carbon steel shall be pickled.</p> <p>Painting for Civil structures shall be done as per relevant part of technical specification</p>			
	9.00.00	QUALITY ASSURANCE PROGRAMME		
	9.01.00	<p>The Contractor shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with IS/ISO-9001.A quality assurance programme of the contractor shall generally cover the following:</p>		
	9.02.00	<p>His organisation structure for the management and implementation of the proposed quality assurance programme</p> <ul style="list-style-type: none">(a) Quality System Manual(b) Design Control System(c) Documentation and Data Control System(d) Qualification data for bidder's key personnel.(e) The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis,		
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	<p>source inspection, incoming raw-material inspection, verification of materials purchased etc.</p> <p>(f) System for shop manufacturing and site erection controls including process, fabrication and assembly.</p> <p>(g) Control of non-conforming items and system for corrective actions and resolution of deviations.</p> <p>(h) Inspection and test procedure both for manufacture and field activities.</p> <p>(i) Control of calibration and testing of measuring testing equipment.</p> <p>(j) System for Quality Audits.</p> <p>(k) System for identification and appraisal of inspection status.</p> <p>(l) System for authorising release of manufactured product to the Employer.</p> <p>(m)System for handling, storage and delivery.</p> <p>(n) System for maintenance of records, and</p> <p>(o) Quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component.</p>			
9.03.00	GENERAL REQUIREMENTS - QUALITY ASSURANCE			
9.03.01	<p>All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award on enclosed format No. QS-01-QAI-P-01/F3.</p>			
9.03.02	<p>Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant</p>			
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	<p>reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. floppy or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.</p>			
9.03.03	<p>Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.</p>			
9.03.04	<p>The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.</p>			
9.03.05	<p>No material shall be dispatched from the manufacturer's works before the same is accepted, subsequent to predispatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for dispatch by issuance of Material Despatch Clearance Certificate (MDCC).</p>			
9.03.06	<p>All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.</p>			
9.03.07	<p>The contractor shall submit to the Employer Field Welding Schedule for field welding activities in the enclosed format No.: QS-01-CQA-W-11/F1. The field welding schedule shall be submitted to the Employer along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.</p>			
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9.03.08	<p>All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer.</p> <p>All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.</p>
9.03.09	All brazers, welders and welding operators employed on any part of the contract either in Contractor's/sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.
9.03.10	Welding procedure qualification & Welder qualification test results shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorised representative.
9.03.11	For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.
9.03.12	Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
9.03.13	No welding shall be carried out on cast iron components for repair.
9.03.14	All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
9.03.15	<p>All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.</p> <p>All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.</p>
9.03.16	The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the sub-contractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished


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	<p>components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval on enclosed format No. QS-01-QAI-P-01/F3. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.</p>			
9.03.17	<p>For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-contractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. With in three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor along with a report of the Purchase Order placed so far for the contract. **</p>			
9.03.18	<p>Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-contractor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.</p>			
9.03.19	<p>The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant</p>			
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9.03.20	codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.		
9.03.21	Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.		
9.03.22	For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.		
9.03.23	Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.		
	Environmental Stress Screening		
	All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the contractor / sub – contractor should meet the following.		
	1) The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.		
	Or		
	In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two or 10% which ever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.		
	<u>Elevated Temperature Test Cycle</u>		
	During the elevated temperature test which shall be for 48 hours, the ambient temperature shall be maintained at 50° C. The equipment shall be interconnected with devices and kept under energized conditions so as to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.		
	During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and		
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	<p>inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature at 50° C.</p> <p>In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.</p>			
	<p>2) <u>Burn in Test Cycle</u></p> <p>The test shall be conducted on all the panels fully assembled and wired including the panels having undergone the above mentioned elevated temperature test.</p> <p>The period of Burn in Test Cycle shall be 120 hrs and process shall be similar to the elevated temperature test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.</p> <p>During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems; the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.</p> <p>During the Burn in Test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature.</p>			
	<p>The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine & acceptance test by employer shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.</p>			
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9.04.00	DOCUMENTATION PACKAGE			
	The Contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick mark.			
9.04.01	Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.			
	The QA Documentation file shall be progressively completed by the Supplier's sub- supplier to allow regular reviews by all parties during the manufacturing.			
	The final quality document will be compiled and issued at the final assembly place of equipment before dispatch. However CD-Rom may be issued not later than three weeks.			
9.04.02	Typical contents of QA Documentation is as below:-			
	(a) Quality Plan			
	(b) Material mill test reports on components as specified by the specification and approved Quality Plans.			
	(c) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.			
	(d) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.			
	(e) Heat Treatment Certificate/Record (Time- temperature Chart)			
	(f) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).			
	(g) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.			
	(h) Certificate of Conformance (COC) wherever applicable.			
	(i) MDCC			
9.04.03	Similarly, the contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.			
9.04.04	Before dispatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted			
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	<p>phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.</p> <p>(a) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.</p> <p>(b) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.</p> <p>(c) If a decision is made dispatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time. The supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the dispatch of equipment.</p>				
	9.04.05	TRANSMISSION OF QA DOCUMENTATION			
	<p>On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Project Site of Employer.</p> <p>For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 3 weeks after the date of the last delivery of equipment.</p>				
	9.05.00	Project Manager’s Supervision			
9.05.01	<p>To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of ‘Arbitration’ clause in Section GCC of Vol.I, the Contractor shall proceed to comply with the Project Manager's decision.</p>				
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9.05.02	<p>The work shall be performed under the supervision of the Project Manager. The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:</p> <ul style="list-style-type: none">(a) Interpretation of all the terms and conditions of these documents and specifications:(b) Review and interpretation of all the Contractor's drawing, engineering data, etc:(c) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :(d) Inspect, accept or reject any equipment, material and work under the contract :(e) Issue certificate of acceptance and/or progressive payment and final payment certificates(f) Review and suggest modifications and improvement in completion schedules from time to time, and(g) Supervise Quality Assurance Programme implementation at all stages of the works.			
9.06.00	INSPECTION, TESTING AND INSPECTION CERTIFICATES			
9.06.01	<p>The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.</p>			
9.06.02	<p>The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.</p>			
9.06.03	<p>The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector's presence and he</p>			
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9.06.04	shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.			
9.06.05	The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.			
9.06.06	When the factory tests have been completed at the Contractor's or sub-contractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.			
9.06.07	In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.			
9.06.08	The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.			
	To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03- of this chapter, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.			
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9.06.09	All inspection, measuring and test equipment used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipment in the presence of Project Manager / Inspector.			
9.07.00	ASSOCIATED DOCUMENT FOR QUALITY ASSURANCE PROGRAMME:			
9.07.01	List of items requiring quality plan and sub supplier approval. Format No.:QS-01-QAI-P-01/F3-R0.			
9.07.02	Manufacturing Quality Plan Format No.: QS-01-QAI-P-09/F1-R1			
9.07.03	Field Quality Plan Format No.: QS-01-QAI-P-09/F2-R1.			
10.00.00	PRE-COMMISSIONING AND COMMISSIONING FACILITIES			
	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. During commissioning the Contractor shall carry out system checking and reliability trials on various parts of the facilities. All pre-commissioning/commissioning activities considered essential for such readiness of the equipment/systems including those mutually agreed and included in the Contractor's quality assurance programme as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the contractor.			
	The pre-commissioning and commissioning activities of the equipment/systems furnished and installed by the contractor shall be the responsibility of the Contractor. The Contractor shall provide, in addition, temporary instrumentation and other measuring devices, 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.			
10.01.00	All erection & commissioning checks shall be as per manufacturer's manual on mutually agreed terms.			
	(a) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Employer and the			
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	<p>Contractor for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Contractor's quality assurance programme as well as those included elsewhere in the Technical Specifications.</p>				
	<p>(b) The Contractor's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.</p>				
	<p>(c) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.</p>				
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11.00.00	<p>(d) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over for commissioning (start-up), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SCL (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] to be furnished by the manufacturer/supplier.</p> <p>(e) The Contractor shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.</p>				
	<p>SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION</p> <p>In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:</p> <p>(a) Working platforms should be fenced and shall have means of access.</p> <p>(b) Ladders in accordance with Employer’s safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.</p>				
12.00.00	<p>PACKAGING AND TRANSPORTATION</p> <p>All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Employer's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.</p>				
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9		PART-G	Page 387 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
13.00.00	ELECTRICAL ENCLOSURE All electrical equipment and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specification.			
14.00.00	INSTRUMENTATION AND CONTROL All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.			
14.01.00	All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale. All scales and charts shall be calibrated and printed in Metric Units			
14.02.00	All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plug-in connection at rear.			
14.03.00	All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalised & components shall be of industrial grade or better.			
15.00.00	ELECTRICAL NOISE CONTROL The equipment furnished by the Contractor shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Contractor's equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-801- 2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems.			
16.00.00	ELECTRONIC MODULE/COMPONENT DETAILS The Bidder shall have to furnish all technical details including circuit diagrams, specifications of components, etc., in respect of each and every electronic card/module as employed on the various solid state as well as			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-G	Page 388 of 415


CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	<p>microprocessor based systems and equipment including conventional instruments, peripherals etc.</p> <p>It is mandatory for the Bidder to identify clearly the custom built ICs used in the package. The Bidder shall also furnish the details of any equivalents of the same.</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-G	Page 389 of 415


CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	Annexure-1 of GTR			
	S. N.	Description Of Documents	No of Prints (Sets)	NO. OF CD-ROMs /Floppy
	1.	Drawings for Initial Submission (Either "FOR APPROVAL" or "FOR INFORMATION Category) and re-submissions after review by NTPC (including Data sheets/ Calculations, all Equipment/instrument schedule, BOM etc)	8	1 Soft Copy (through 2 sets of Floppy or 1 no of CD-Rom or through E-Mail)
	2.	Final Approved Drawings (Cat-I & Cat – IV Approved) (As referred in SI no: 1 above)	3	4 CD- Roms
	3.	Documents / Drawings "AS BUILT "	3	4 CD- Roms
	4.	Type test reports (Intial)	8	1 Soft Copy (through 2 sets of Floppy or 1 no of CD-Rom or through E-Mail)
	5	Type test reports (Final)	1	2 CD-Roms
	6.	Piping / Equipment Analysis (Transient) etc, Model study reports (Draft) Including the input/ output data etc.	8	1 Soft Copy (through 2 sets of Floppy or 1 no of CD-Rom or through E-Mail)
	7.	Piping / Equipment Analysis (Transient) etc, Model study reports (Final Approved) Including the input/ output data etc.	2	4 CD-Roms
	8	Erection manual "Draft "	4 sets	1 CD ROMS
	8	Erection manual "Final "	4 sets	1 CD ROMS
	9	Operation & Maintenance manual "DRAFT"	4 sets	2 CD ROMS
10	Operation & Maintenance manual "FINAL"	4 sets	4 CD ROMS	
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CLAUSE NO.	TECHNICAL SPECIFICATIONS				
	Annexure-1 of GTR				
	S. N.	Description Of Documents	No of Prints (Sets)	NO. OF CD-ROMs /Floppy	
	11	Commissioning Procedure (If applicable) (DRAFT)	4 sets	1 CD ROMS	
	12.	Commissioning Procedure (If applicable) (FINAL)	4 sets	1 CD ROMS	
	13	Performance and Guarantee test Procedure (Draft)	8	1 Soft Copy (through 2 sets of Floppy or 1 no of CD-Rom or through E-Mail)	
	14.	Performance and Guarantee test Procedure (Final)	8	1 Soft Copy (2 Floppy or 1 no of CD-Rom or through E-Mail)	
	16	Progress Reports	8	3 FLOPPIES	
	16	Project completion report	3 Sets	3CD ROMS	
	17	QA programme including Organisation for implementation and QA system manual (with revision-servicing)	1	1 CD-ROM	
	18	Vendor details in respect of proposed vendors including contractor's evaluation report.	1	1 CD –ROM	
	19	Manufacturing QPs, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, POR etc.			
		i) For review/comment	- 3	1 set of soft copy	
	(ii) For final approval	1 set floppies 4	1 CD ROM		
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CLAUSE NO.	TECHNICAL SPECIFICATIONS				
	Annexure-1 of GTR				
	S. N.	Description Of Documents	No of Prints (Sets)	NO. OF CD-ROMs /Floppy	
	20	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals			
		Draft	4 sets		
		Final	4 sets	2 CD ROMS	
	21	Monthly Vendor Approval /QP approval status	2 sets	1 FLOPPY	
	22	QA Documentation Package for items / equipment manufactured and dispatched to site	2 Sets	2 CD ROMS	
	23	QA Documentation Package for field activities on equipment / systems at site	2 Sets	2 CD ROMS	
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			<div>एनटीपीसी NTPC</div>
	<div>PART-H</div> <div>ERECTION CONDITIONS OF CONTRACT</div>			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
	<u>ERECTION CONDITIONS OF CONTRACT</u>			
1.00.00	GENERAL			
1.01.00	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.			
1.02.00	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.			
2.00.00	CODE REQUIREMENTS			
	The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant Government of India Rules & Codes, accepted good practices in the industry and shall fulfill all statutory requirements.			
3.00.00	ELECTRICAL SAFETY REGULATIONS			
	The contractor shall ensure that entire electrical installation work is executed by adopting applicable statutory safety regulations and best practices in the industry. The Contractor shall employ the necessary number of qualified, full time electricians to maintain his temporary electrical installation.			
4.00.00	INSPECTION AND TESTING INSPECTION CERTIFICATES			
	The provisions of the clause entitled Inspection and Testing in 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			
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
5.00.00	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.			
	CONTRACTOR'S SITE OFFICE ESTABLISHMENT			
6.00.00	The Contractor shall establish an Office at the Site and keep posted an authorised representative for the purpose of the Contract. Any written order or instruction of the 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			
	CONTRACTOR'S FIELD OPERATION			
7.00.00	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.			
	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 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.			
	PROTECTION OF WORK			
	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 any other agency/individual not being under his			
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8.00.00	<p>supervision or control, the Contractor shall make his claim directly with the party concerned. 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>			
	<p>FACILITIES TO BE PROVIDED BY THE CONTRACTOR</p>			
	<p>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.</p>			
	<p>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. The Contractor shall arrange machinery & equipment such as Dozer, Hydra, Cranes, Trailer, etc. wherever required for the purpose of fabrication, erection and commissioning.</p>			
9.00.00	<p>Testing Equipment and Facilities:</p> <p>The contractor shall provide the necessary testing, equipment and facilities.</p>			
	<p>Testing of construction material at the site:</p> <p>Contractor shall make arrangements for the testing of construction material at the site wherever required, under the scope of services of the contract.</p>			
	<p>First-aid</p> <p>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>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.</p>			
<p>FIRE PROTECTION</p>				
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CLAUSE NO.	TECHNICAL SPECIFICATIONS			
10.00.00	<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 regularly. 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> <p>All materials used for storage or for handling of materials 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> <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> <p>The Contractor shall provide suitable quantity & type fire protection equipment for the warehouses, office, temporary structures etc.</p>			
	<p>SECURITY</p> <p>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.</p>			
	<p>PACKAGING AND TRANSPORTATION</p> <p>All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Contractor shall ascertain the availability of Railway wagon</p>			
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12.00.00	<p>sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & preassembly to bare minimum. The Employer's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.</p>				
	<p>CRATING</p>				
	<p>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>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>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>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>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>Equipment having antifriction or sleeve bearings shall be protected by weather tight enclosures.</p>				
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13.00.00	<p>Coated surfaces shall be protected against impact, abrasion, discolouration and other damage. Surfaces which are damaged shall be repaired.</p> <p>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>Provisions shall be made to ensure that water does not enter any equipment during shipment or in storage at the plant site.</p> <p>Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.</p> <p>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>MATERIALS HANDLING AND STORAGE</p>			
	<p>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.</p>			
	<p>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.</p>			
	<p>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.</p>			
	<p>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.</p>			
	<p>All the electrical equipment such as motors, etc. shall be periodically tested for insulation resistance from the date of receipt till the date of commissioning</p>			
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14.00.00	<p>and a record of such measured insulation values maintained by the Contractor. Such records shall be open for inspection by the Employer.</p> <p>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.</p> <p>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.</p> <p>All the materials stored in the open or dusty location must be covered with suitable weatherproof and flameproof covering material wherever applicable.</p>			
	<p>CONSTRUCTION MANAGEMENT</p> <p>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.</p> <p>The Employer shall however not be responsible for provision of additional labour and/or materials or supply or any other services to the Contractor.</p>			
	<p>FIELD OFFICE RECORDS</p> <p>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 available for inspection & review to the Employer.</p>			
16.00.00	<p>PROTECTION OF PROPERTY AND CONTRACTOR'S LIABILITY</p> <p>The Contractor shall be responsible for any damage resulting from his operations. He shall also be responsible for protection of all persons</p>			
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CLAUSE NO.	<div>  TECHNICAL SPECIFICATIONS </div>
<div>17.00.00</div> <div>18.00.00</div> <div>19.00.00</div> <div>20.00.00</div>	<p>including members of public and employees of the Employer and his own employees and all public and private property including structures, building, other plants and equipments and utilities either above or below the ground.</p> <p>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.</p> <p>PAINTING</p> <p>All exposed metal parts of the equipment including pipings, structure railings, etc. wherever applicable, after installation unless otherwise surface protected, shall be first painted in accordance with relevant codes & standards, after thoroughly cleaning all such parts of all dirt, rust, scales, greases, oils and other foreign materials by wire brushing, scraping or sand blasting.</p> <p>UNFAVOURABLE WORKING CONDITIONS</p> <p>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.</p> <p>PROTECTION OF MONUMENTS AND REFERENCE POINTS</p> <p>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.</p> <p>FOUNDATION DRESSING & GROUTING FOR EQUIPMENT/ EQUIPMENT BASES</p> <p>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.</p>
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20.03.00	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.			
21.00.00	SHAFT ALIGNMENTS All the shafts of rotating equipment shall be properly aligned to those of the matching equipments to as perfect 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 VDI 2056. All bearings, shafts and other rotating parts shall be thoroughly cleaned and suitably lubricated before starting.			
22.00.00	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.			
23.00.00	CABLING 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. 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.			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-H	Page 403 of 415


CLAUSE NO.	TECHNICAL SPECIFICATIONS			
24.00.00	<p>Sharp bending and kinking of cables shall be avoided. 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.</p> <p>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.</p> <p>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 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.</p> <p>The connectors for control cables shall be covered with a transparent insulating sleeve so as to prevent accidental contact with ground or adjacent terminals and shall preferably terminate in Elmex terminals and washers. The insulating sleeve shall be fire resistant and shall be long enough to over pass the conductor insulation. All control cables shall be fanned out and connection made to terminal blocks and test equipment for proper operation before cables are corded together.</p>			
	EQUIPMENT INSTALLATION			
	24.01.00	General Requirements		
	<p>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>Contractor shall prepare detailed installation drawings for each equipment furnished under this specification. Installation of all equipment/systems furnished by this specification shall be as per installation drawings.</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-H	Page 404 of 415


CLAUSE NO.	TECHNICAL SPECIFICATIONS			
24.02.00	Erection procedures not specified herein shall be in accordance with the recommendations of the equipment manufacturers. The procedures shall be acceptable to the Employer.			
	The Contractor shall coordinate his work with other suppliers where their instruments and devices are to be installed under specifications.			
	Installation Materials			
	All materials required for installation, testing and commissioning of the equipment shall be furnished by the Contractor.			
	Regulatory Requirements			
24.03.00	All installation procedures shall confirm with the accepted good engineering practice and with all applicable governmental laws, regulations and codes.			
	Cleaning			
24.04.00	All equipment shall be cleaned of all sand, dirt and other foreign materials immediately after removal from storage and before the equipment is installed.			
	Installation of Field Mounted Instruments/Devices and Non-free Standing Equipment			
24.05.00	The installation drawings for all field mounted equipment/instrument/devices furnished under this specification shall meet the requirements of this specification, applicable codes and standards and recommendations of manufacturers of instruments/devices. In addition to above relevant Portion as specified elsewhere in technical specification may be referred.			
	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.			
	All free standing instrumentation cabinets and panels shall be located within the construction tolerances of +/- 3 mm of the location dimensions indicated on the plant arrangement drawings.			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-H	Page 405 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
25.00.00	DEVIATIONS DISPOSITIONING: 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.			
26.00.00	STATUTORY REQUIREMENTS 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. 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 any 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.			
27.00.00	EMPLOYMENT OF LABOUR 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. All travelling expenses including provisions of all necessary transport to and from Site, lodging allowances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor. 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, Contract 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.			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-H	Page 407 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
28.00.00	WORK & SAFETY REGULATIONS			
	The Contractor shall ensure proper safety of all the workmen, materials, plant and equipments belonging to him or to Employer or to others, working at the Site. The Contractor shall also be responsible for provision of all safety notices and safety equipment required both by the relevant legislation and the Employer as he may deem necessary.			
28.01.00	<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 employer. In case, any approvals are necessary from the chief inspector (explosives) or any statutory authorities, the contractor shall be responsible for obtaining the same.</p> <p>Where explosives are to be used, the same shall be used under the direct control and supervision of an expert, experienced, qualified and competent person strictly in accordance with the Code of Practices/Rules framed under Indian Explosives Act pertaining to handling, storage and use of explosives.</p>			
28.02.00	All equipment used in construction and erection by Contractor shall meet Indian/International Standards and where such standards do not exist, the Contractor shall ensure these to be absolutely safe. All construction and erection equipments shall be strictly operated and maintained by the Contractor in accordance with statutory safety regulations. Periodical Examinations and all tests for all lifting/ hoisting equipment & tackles shall be carried-out in accordance with the relevant provisions of Factories Act 1948, Indian Electricity Act 1910 and associated Laws/Rules in force from time to time.			
28.03.00	<p>The Contractor shall provide suitable safety equipment of prescribed standard to all employees and workmen according to the need, as may be directed by Employer who will also have right to examine these safety equipments to determine their suitability, reliability, acceptability and adaptability.</p> <p>(a) Working platforms should be fenced and shall have means of access.</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-H	Page 408 of 415

CLAUSE NO.		TECHNICAL SPECIFICATIONS									
28.04.00	<p>(b) Ladders in accordance with statutory safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.</p> <p>The Contractor shall provide safe working conditions to all workmen and employees at the Site including safe means of access, railings, stairs, ladders, scaffoldings etc. The scaffoldings shall be erected under the control and supervision of an experienced and competent person. For erection, good and standard quality of material only shall be used by the Contractor.</p>										
	<p>The Contractor employing more than 250 workmen whether temporary, casual, probationer, regular or permanent or on contract, shall employ atleast one full time officer exclusively as Safety Officer to supervise safety aspects of the equipments and workmen, who will co- ordinate with the Employer Safety Officer. In case of work being carried out through sub-Contractors, the Sub-Contractor's workmen/employees will also be considered as the Contractor's employees/workmen for the above purpose.</p>										
	<p>In case any accident occurs during the construction/ erection or other associated activities undertaken by the Contractor thereby causing any 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 Employer and also to all the authorities envisaged under the applicable laws.</p>										
	<p>The Contractor shall follow and comply with 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 demur, protest or contest or reservation.</p>										
	<p>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 equipment and plant and for the safety of personnel and the Contractor does not prevent hazardous conditions which cause injury to his own employees or employees of other Contractors, or the Employer's employees or any other person who are at Site or adjacent thereto, the Contractor shall be responsible for payment of compensation to Employer as per the following schedule:-</p>										
	<table><tr><td>1</td><td>Fatal injury or accident. These are causing death applicable</td><td>Rs. 1,00,000/- per person</td></tr><tr><td>2</td><td>Major injuries or accident</td><td>Rs. 20,000/- per personfor death/ causing 25% or more injury to any</td></tr></table>	1	Fatal injury or accident. These are causing death applicable	Rs. 1,00,000/- per person	2	Major injuries or accident	Rs. 20,000/- per personfor death/ causing 25% or more injury to any				
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DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9		PART-H	Page 409 of 415						

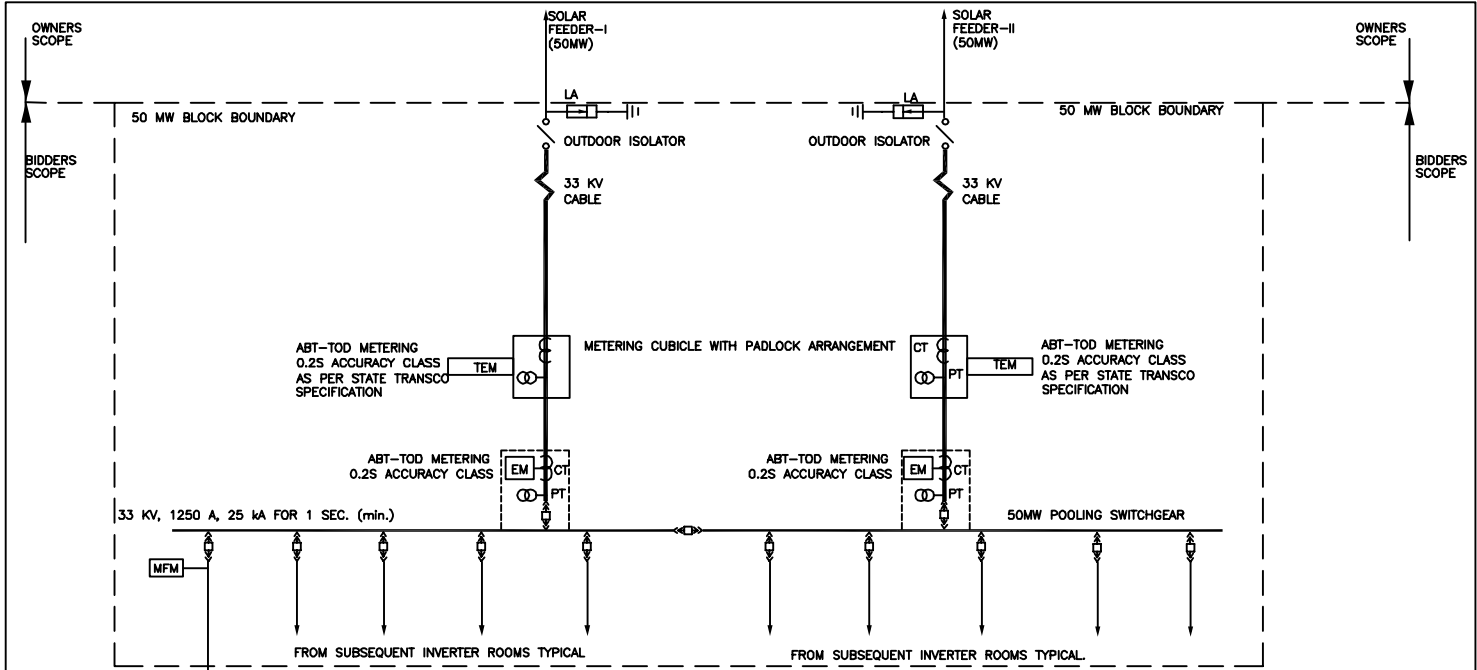
CLAUSE NO.	TECHNICAL SPECIFICATIONS			
29.00.00			permanent disablement to person workmen or employees whosoever	
	Permanent disablement shall have same meaning as indicated in Workmen's Compensation Act. The compensation mentioned above shall be in addition to the compensation payable to the workmen/employees under the relevant provisions of the Workmen's Compensation Act and rules framed thereunder or any other applicable laws as applicable from time to time. In case the Employer is made to pay such Compensation then the Contractor is liable to reimburse the Employer such amount in addition to the compensation indicated above.			
	If the Contractor observes all the Safety Rules and Codes, Statutory Laws and Rules during the currency of Contract awarded by the Employer and no accident occurs then the Employer may consider the performance of the Contractor and award suitable "ACCIDENT FREE SAFETY MERITORIOUS AWARD" as per scheme as may be announced separately from time to time.			
	INSURANCE			
29.01.00	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 and all statutory obligations shall be fulfilled.			
	WORKMEN'S COMPENSATION INSURANCE			
29.02.00	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, disability 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 liabilities shall not be less than the following:			
	Workmen's Compensation - As per Statutory Provisions			
	Employee's Liability - As per Statutory Provisions			
29.02.00	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			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-H	Page 410 of 415

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
29.03.00	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:			
	Fatal Injury : Rs.100,000 each person			
	: Rs.200,000 each occurrence			
	Property Damage : Rs.100,000 each occurrence			
	COMPREHENSIVE GENERAL LIABILITY INSURANCE			
	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).			
	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.			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9		PART-H
				Page 411 of 415

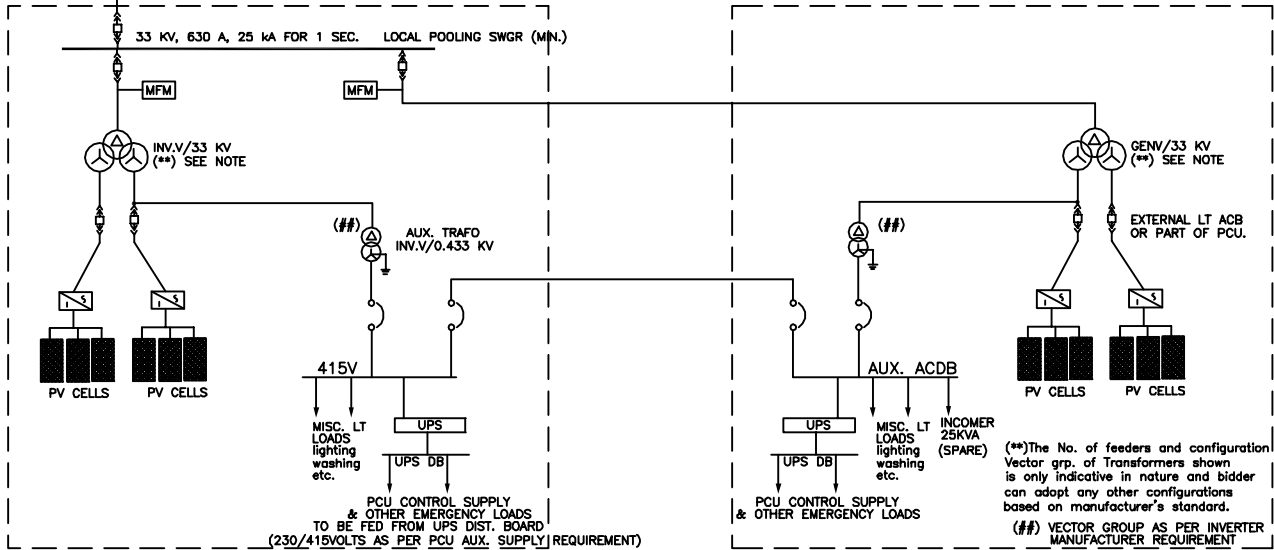
PART-I

LIST OF TENDER DRAWINGS

CLAUSE NO.	TECHNICAL SPECIFICATIONS																							
	<div>PART-I LIST OF TENDER DRAWINGS</div> <table><tr><th>Sl. No.</th><th>DRAWING NO.</th><th>TITLE</th></tr><tr><td>1.</td><td>5714-004-POE-A- 006 -1 AND 2 Rev A</td><td>Single line diagram –Power Evacuation System</td></tr><tr><td>2.</td><td>5714-004-POE-A- 007</td><td>Installation methodology of buried cables</td></tr><tr><td>3.</td><td>5714-004-POC-A-003 Rev B</td><td>Details of Chain Link Fencing</td></tr><tr><td>4.</td><td>5714-004-POC-A-004 Rev A</td><td>Details of Main Gate</td></tr><tr><td>5.</td><td>5714-004-POC-A-005 Rev A</td><td>Inverter Room – Pre Engineered Building Architectural Plan, Elevation, Section details</td></tr><tr><td>6.</td><td>5714-004-POC-A-002 Rev-A</td><td>Typical detail of Approach Roads drawing no:</td></tr></table>			Sl. No.	DRAWING NO.	TITLE	1.	5714-004-POE-A- 006 -1 AND 2 Rev A	Single line diagram –Power Evacuation System	2.	5714-004-POE-A- 007	Installation methodology of buried cables	3.	5714-004-POC-A-003 Rev B	Details of Chain Link Fencing	4.	5714-004-POC-A-004 Rev A	Details of Main Gate	5.	5714-004-POC-A-005 Rev A	Inverter Room – Pre Engineered Building Architectural Plan, Elevation, Section details	6.	5714-004-POC-A-002 Rev-A	Typical detail of Approach Roads drawing no:
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5.	5714-004-POC-A-005 Rev A	Inverter Room – Pre Engineered Building Architectural Plan, Elevation, Section details																						
6.	5714-004-POC-A-002 Rev-A	Typical detail of Approach Roads drawing no:																						
DEVELOPMENT OF 260 MW (4 BLOCKS OF 65 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN RAJASTHAN		TECHNICAL SPECIFICATION BID DOC. NO:CS-5716-004-9	PART-I																					
			Page 413 of 415																					



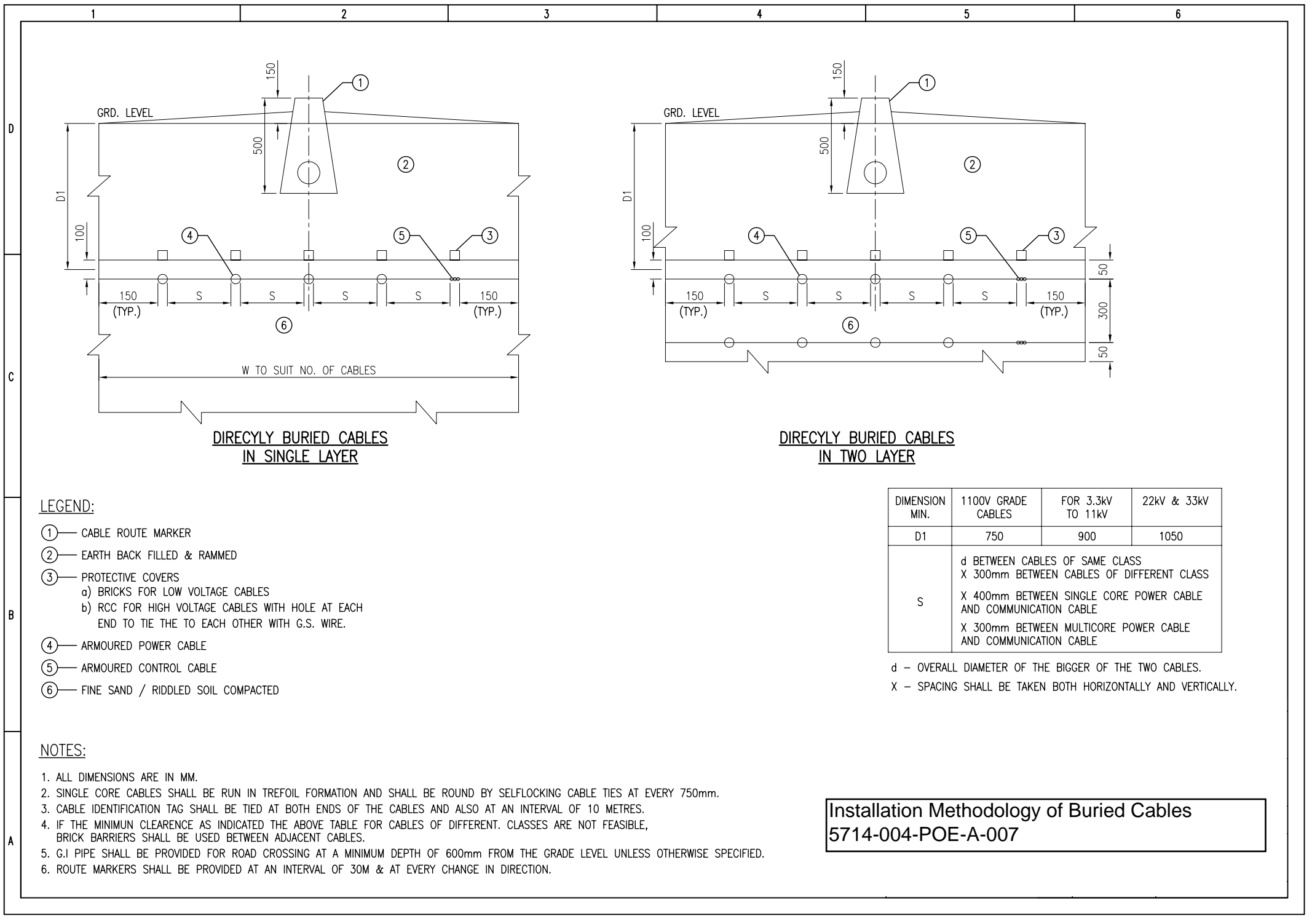
TYPICAL SCHEME FOR INVERTER ROOM TYPICAL



NOTES:

- 33KV MAIN POOLING SWITCHGEAR SHALL BE KEPT IN ONE OF THE INVERTER ROOMS AND AUXILIARY POWER OF POOLING SWGR. AND SCADA SHALL BE FED FROM AUXILIARY POWER ACDB OF THAT INVERTER ROOM.
- IF PCU REQUIRES AUXILIARY POWER SUPPLY FROM EXTERNAL POWER SOURCE EPC VENDOR SHALL PROVIDE SUITABLE UPS FOR FEEDING AUXILIARY POWER OF PCU AND OTHER PROTECTION, CONTROL AND OTHER EMERGENCY LOADS.
- IN CASE PCU DOES NOT NEED ANY EXTERNAL AUXILIARY POWER SUPPLY EPC VENDOR CAN PROVIDE SUITABLE DC SYSTEM (IN PLACE OF UPS) FOR PROTECTION, CONTROL AND OTHER EMERGENCY LOADS
- UPS SHALL BE THREE PHASE TO SINGLE/THREE PHASE WITH BACKUP TIME OF 2 HOURS.
- EPC BIDDER CAN OPTIMISE NUMBER OF INVERTERS KEPT IN ONE INVERTER ROOM AND NUMBER OF FEEDERS IN 33KV MAIN POOLING SWITCHGEAR AS PER ITS OWN TECHNO-ECONOMIC EVALUATION.
- 33 KV CABLE UP TO 50 MW BLOCK BOUNDARY WALL IS UNDER SCOPE OF BIDDER.
- OUTDOOR ISOLATOR & LA ALONG WITH SUPPORT STRUCTURE, CIVIL WORK, SUITABLE TERMINAL CONNECTOR TO RECEIVE EXTERNAL CABLE (50MW EACH) AND FENCING AS REQUIRED SHALL BE IN BIDDER'S SCOPE .
- BIDDER SHALL TERMINATE 33KV OUTGOING FEEDER CABLES ON THEIR BLOCK BOUNDARY AT A POINT NEAREST TOWARDS 33/220KV POOLING SWITCHYARD.
- BIDDER CAN USE CABLE OR SUITABLY RATED OVERHEAD LINE (on pole) FOR CONNECTING LOCAL POOLING SWITCHGEAR TO 50MW MAIN POOLING SWITCHGEAR. HOWEVER OUTAGE OF ANY ONE OF THESE FEEDER IN MAIN POOLING SWITCHGEAR SHALL NOT RESULT IN LOSS OF MORE THAN 15 MW OF SOLAR GENERATION.
- IN CASE BIDDER USES O/H LINE FOR THIS CONNECTION SUITABLE CORRIDORS FOR THE LINE SHALL BE KEPT AS PER DETAILED SHADOW EFFECT ANALYSIS CARRIED OUT BY THE BIDDER.

NTPC Limited		SOLAR POWER PROJECT AT MADHYA PRADESH (8 X 50 MW)	
BASIC SINGLE LINE DIAGRAM		FOR 50 MW BLOCK	
REV.	NO.	DATE	BY
5714-004-POE-A-006/2	A		



**DIRECYLY BURIED CABLES
IN SINGLE LAYER**

**DIRECYLY BURIED CABLES
IN TWO LAYER**

LEGEND:

- ① — CABLE ROUTE MARKER
- ② — EARTH BACK FILLED & RAMMED
- ③ — PROTECTIVE COVERS
 - a) BRICKS FOR LOW VOLTAGE CABLES
 - b) RCC FOR HIGH VOLTAGE CABLES WITH HOLE AT EACH END TO TIE THE TO EACH OTHER WITH G.S. WIRE.
- ④ — ARMOURED POWER CABLE
- ⑤ — ARMOURED CONTROL CABLE
- ⑥ — FINE SAND / RIDDLED SOIL COMPACTED

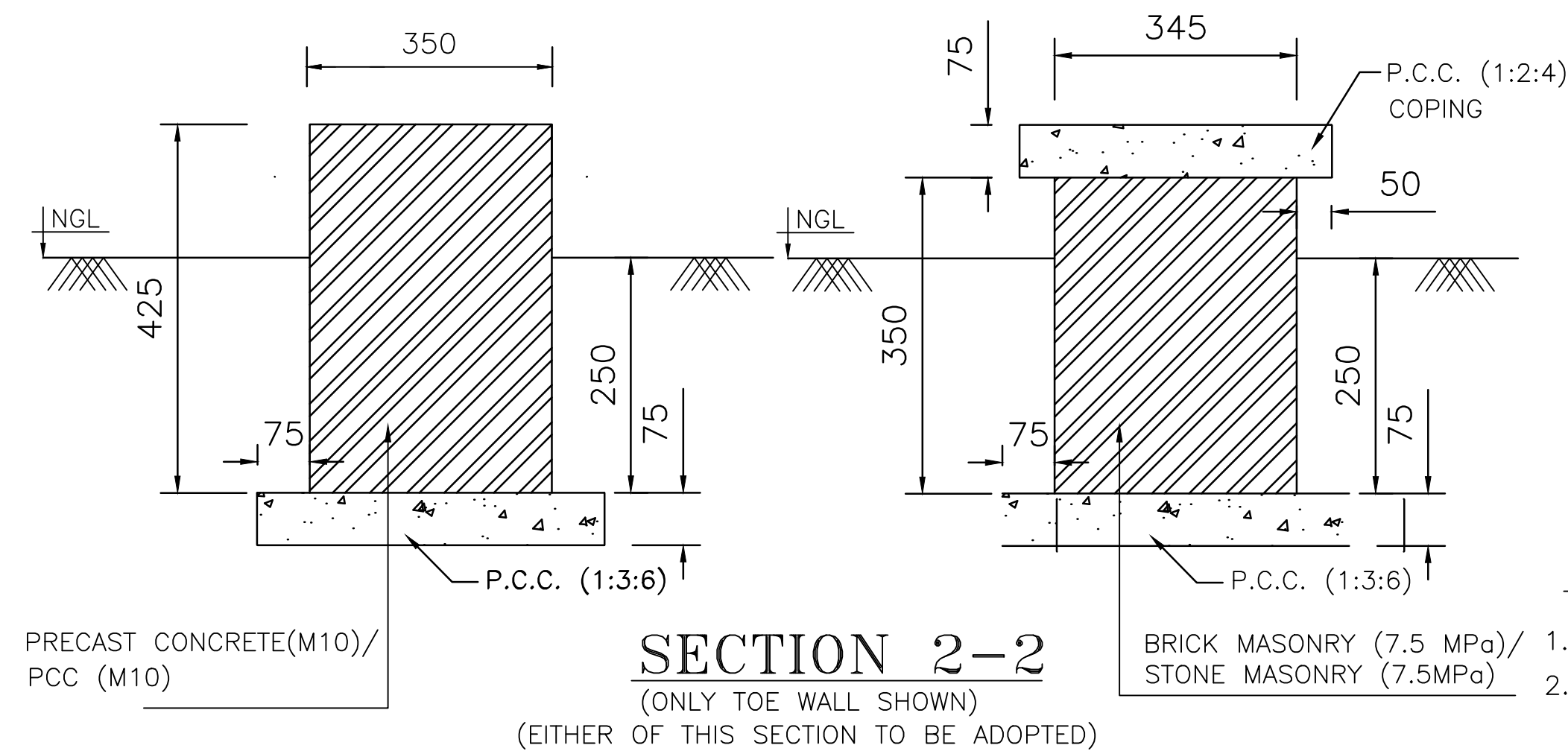
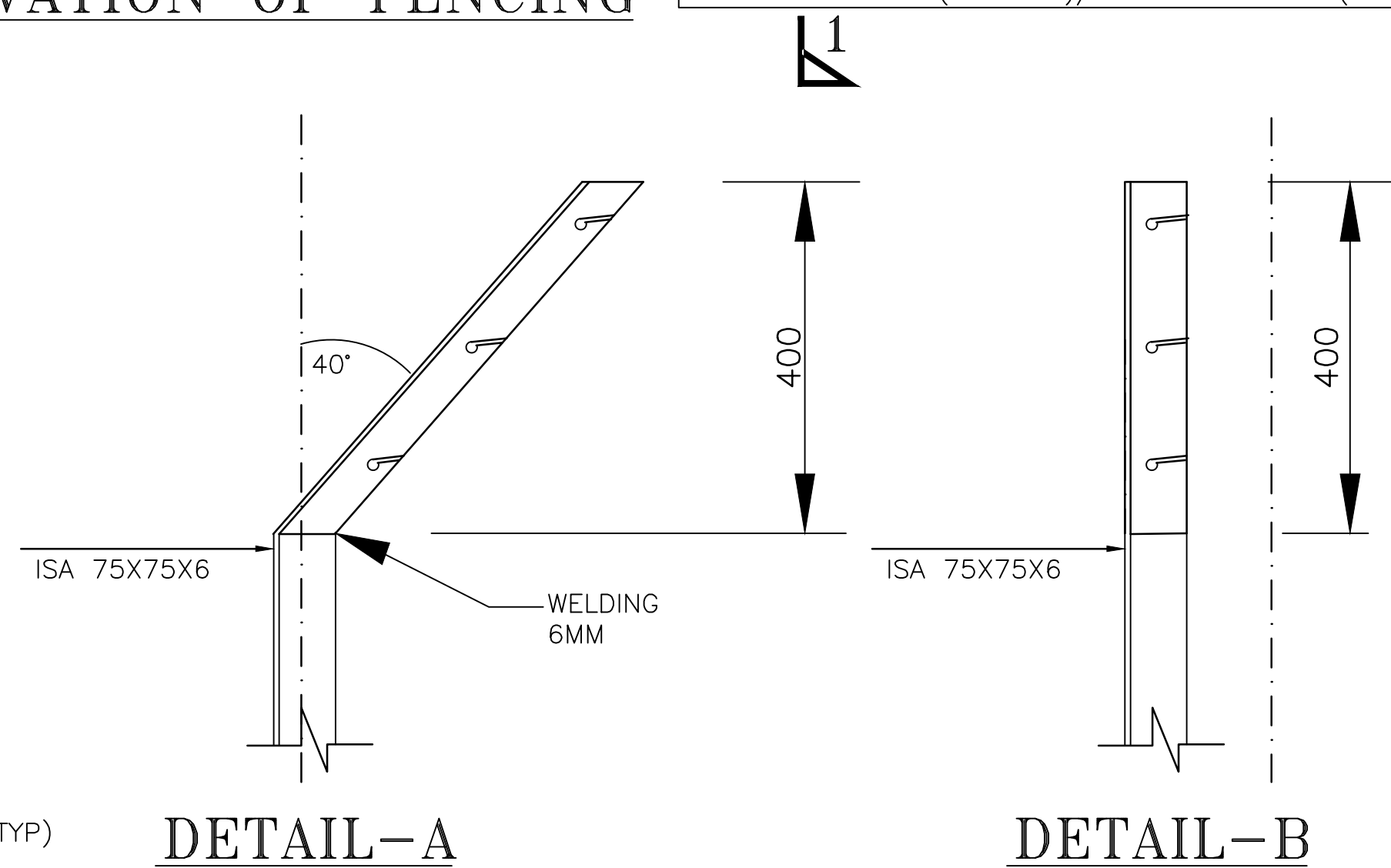
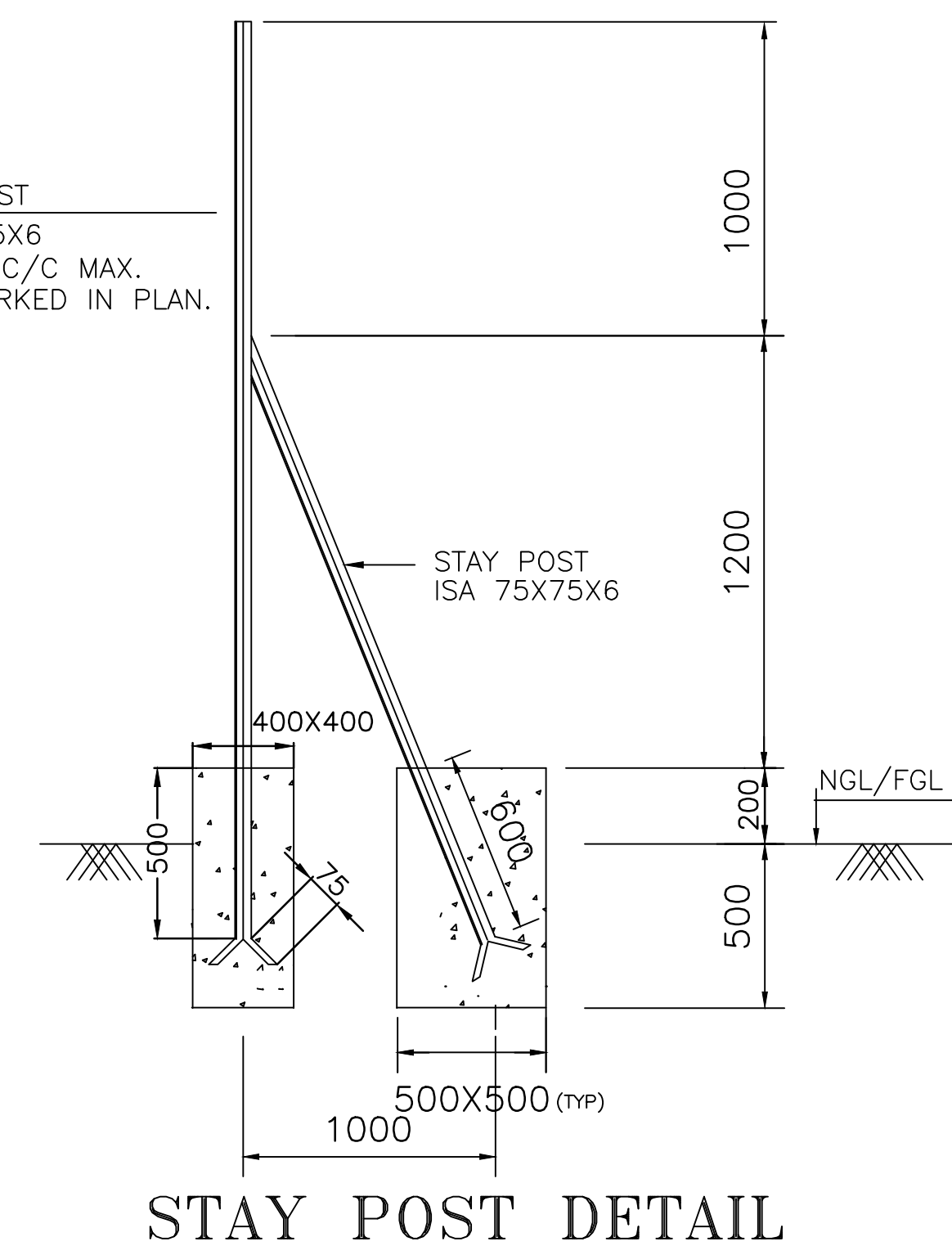
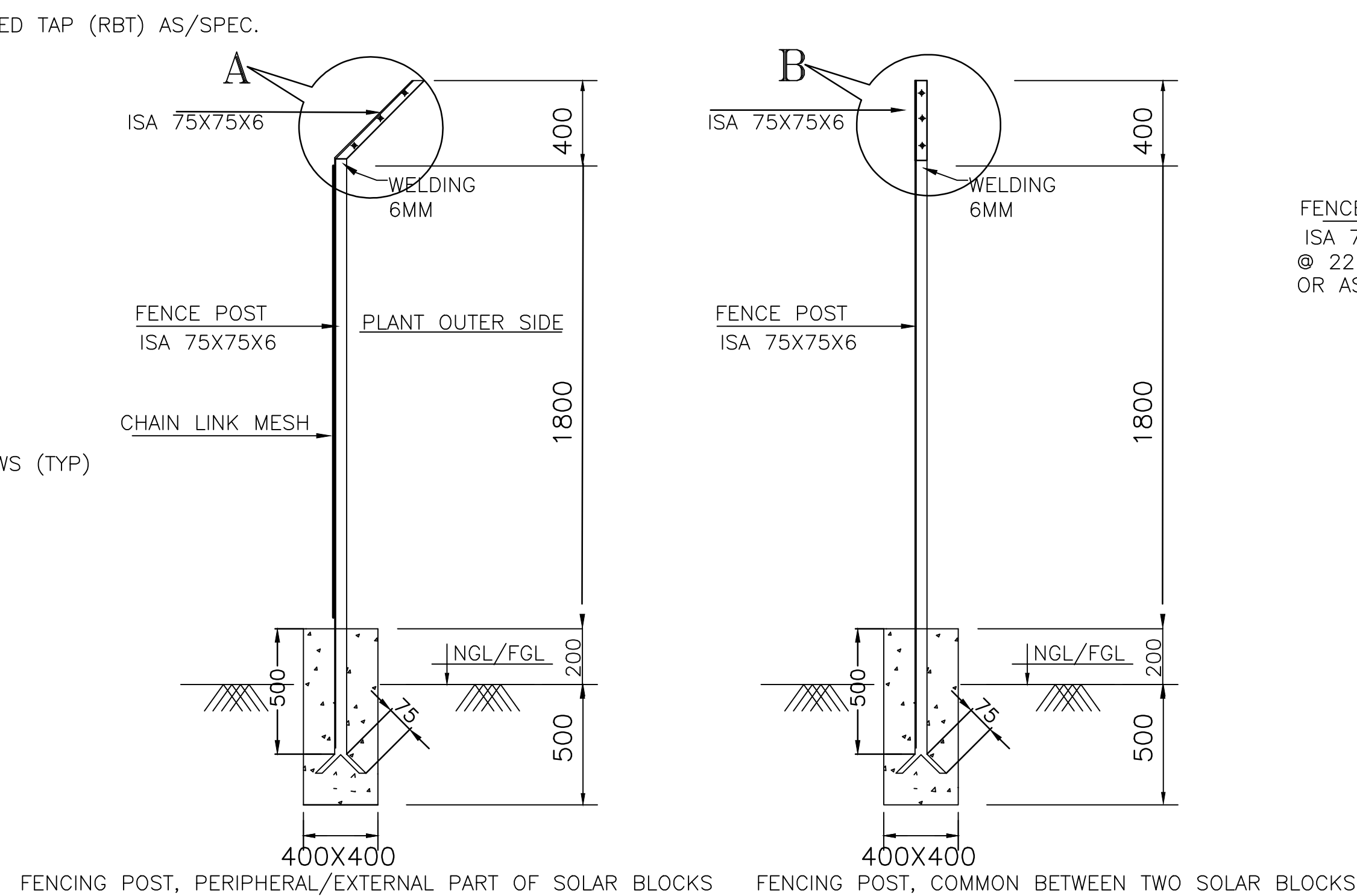
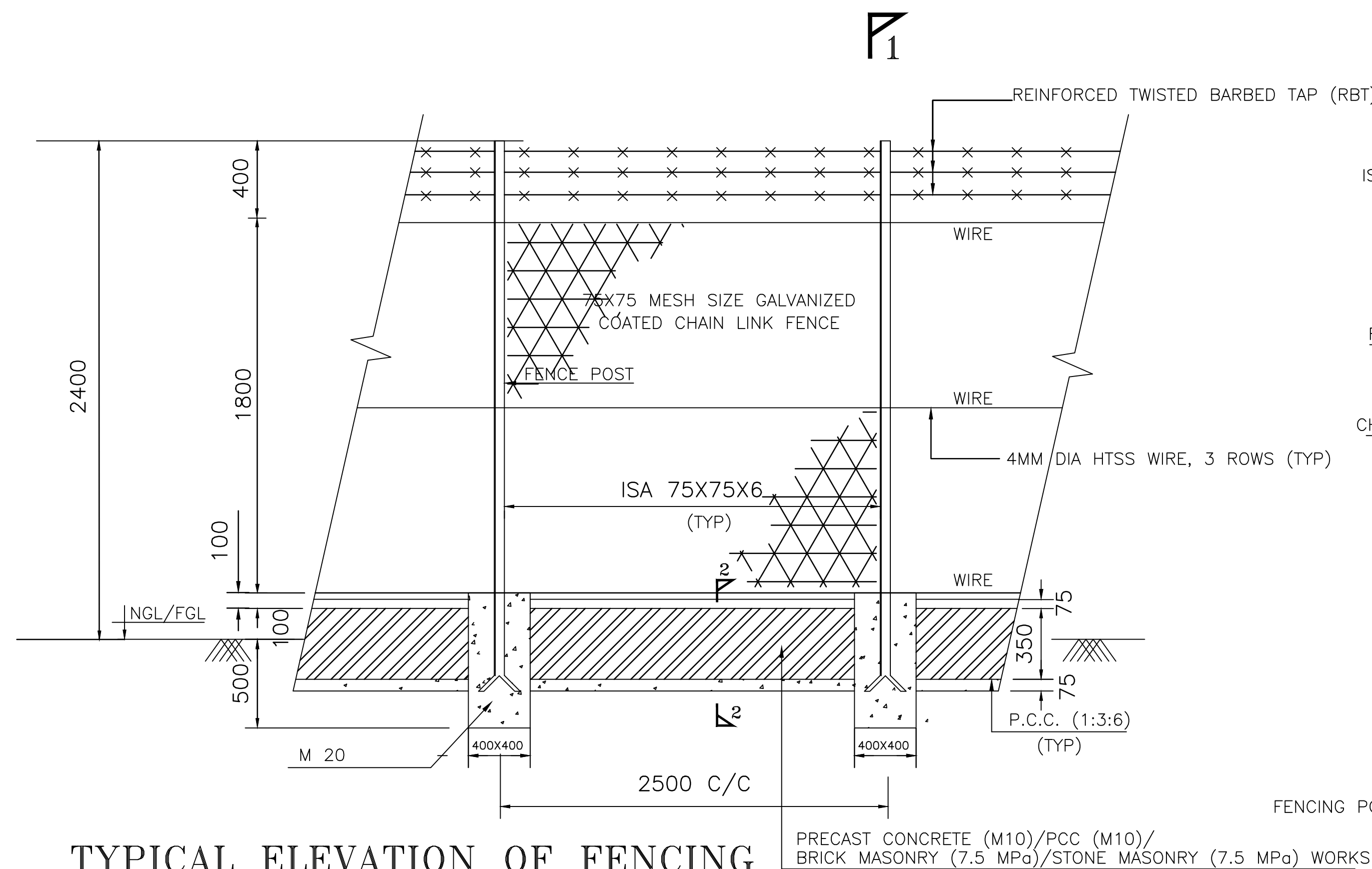
NOTES:

1. ALL DIMENSIONS ARE IN MM.
2. SINGLE CORE CABLES SHALL BE RUN IN TREFOIL FORMATION AND SHALL BE ROUND BY SELFLOCKING CABLE TIES AT EVERY 750mm.
3. CABLE IDENTIFICATION TAG SHALL BE TIED AT BOTH ENDS OF THE CABLES AND ALSO AT AN INTERVAL OF 10 METRES.
4. IF THE MINIMUM CLEARANCE AS INDICATED THE ABOVE TABLE FOR CABLES OF DIFFERENT. CLASSES ARE NOT FEASIBLE, BRICK BARRIERS SHALL BE USED BETWEEN ADJACENT CABLES.
5. G.I PIPE SHALL BE PROVIDED FOR ROAD CROSSING AT A MINIMUM DEPTH OF 600mm FROM THE GRADE LEVEL UNLESS OTHERWISE SPECIFIED.
6. ROUTE MARKERS SHALL BE PROVIDED AT AN INTERVAL OF 30M & AT EVERY CHANGE IN DIRECTION.

DIMENSION MIN.	1100V GRADE CABLES	FOR 3.3kv TO 11kv	22kv & 33kv
D1	750	900	1050
S	d BETWEEN CABLES OF SAME CLASS X 300mm BETWEEN CABLES OF DIFFERENT CLASS X 400mm BETWEEN SINGLE CORE POWER CABLE AND COMMUNICATION CABLE X 300mm BETWEEN MULTICORE POWER CABLE AND COMMUNICATION CABLE		

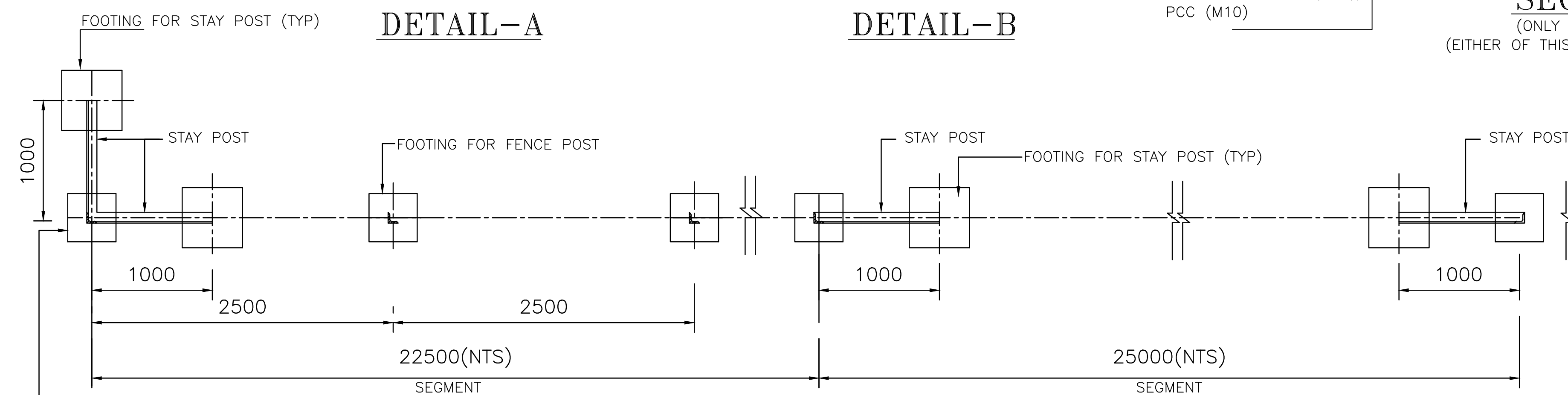
d - OVERALL DIAMETER OF THE BIGGER OF THE TWO CABLES.
X - SPACING SHALL BE TAKEN BOTH HORIZONTALLY AND VERTICALLY.

Installation Methodology of Buried Cables
5714-004-POE-A-007



NOTES:

1. ALL LEVELS ARE IN METRES & DIMENSIONS ARE IN MM.
2. MS ANGLE POSTS ARE TO BE GALVANISED AS PER SPECIFICATIONS.
3. CHAIN LINK FENCE & FIXING DETAILS INCLUDING MATERIAL FOR THE WORKS SHALL BE AS PER IS : 2721 (2003) & AS PER TECHNICAL SPECIFICATIONS.
4. HTSS WIRE AND CHAIN LINK FENCE SHALL BE ERECTED ONLY AFTER ERECTION OF EACH SEGMENT OF FENCE POSTS AND STAY POSTS. SEGMENT IS AS SHOWN IN THE PLAN.
5. ALL PCC SHALL BE MIN 75 MM THICK
6. THE DEPTH OF FOUNDATION SHALL BE TAKEN FROM NGL AND HEIGHT OF STRUCTURE SHALL BE TAKEN ABOVE FGL.



FOR TENDER PURPOSE ONLY



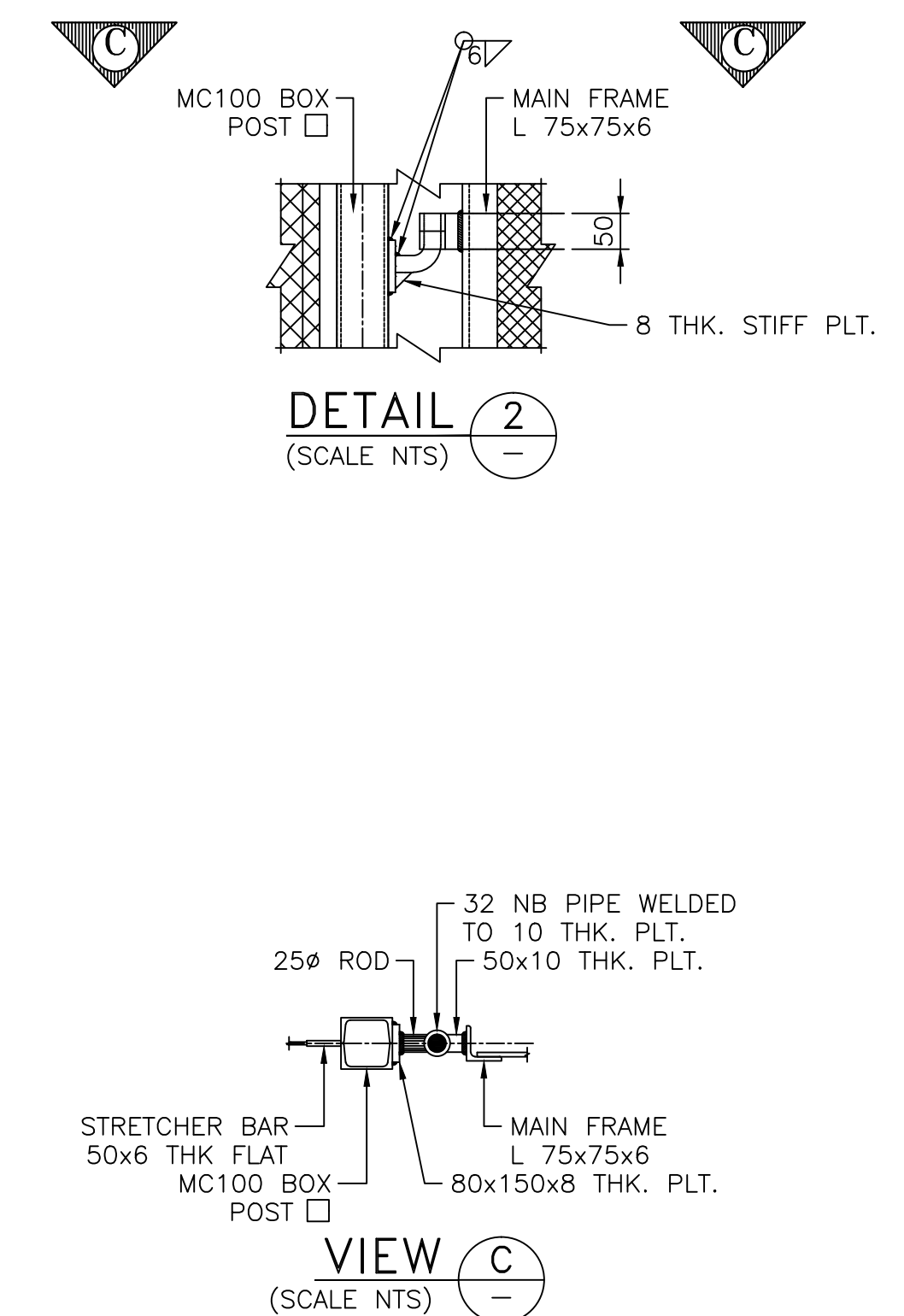
NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT	DEVELOPMENT OF 250 MW (5X50 MW) SOLAR PV PROJECT IN MANDSUAR DISTRICT OF MP.
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TITLE	DETAILS OF CHAIN LINK FENCING
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0	FOR TENDER PURPOSE ONLY	LDB	LDB	CMV	-	-		-	-		
REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ES	APPD	DATE
					CLEARED BY						

DATE	SIZE	SCALE	DRG. NO.	REV. NO.
15.15	A1	NTS	5714-004-POC-A-003	B



FGL FINISH GROUND LEVEL
 NTS NOT TO SCALE
 TYP TYPICAL
 EL ELEVATION

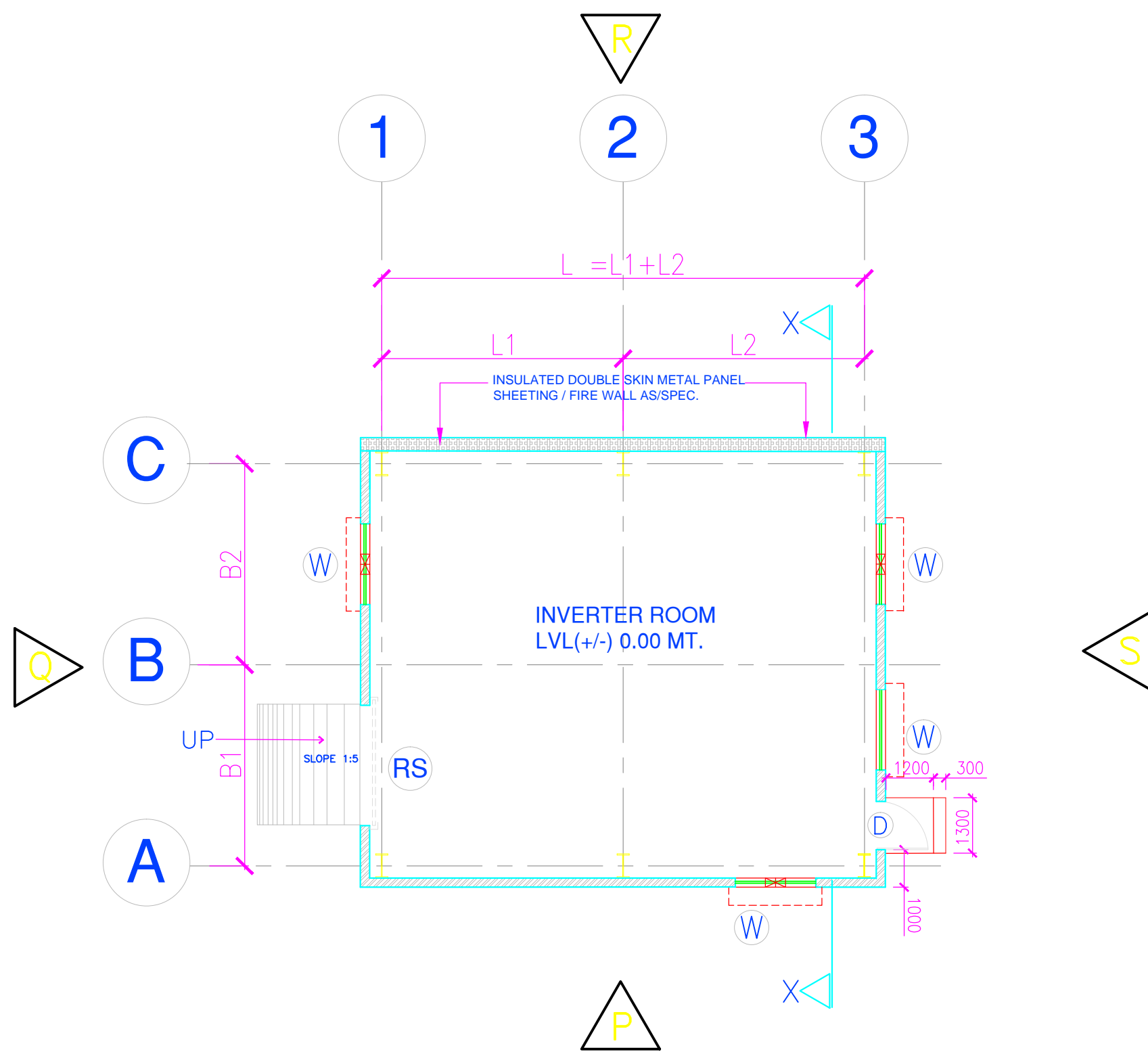
NOTE:

1. ALL LEVELS ARE IN METERS & DIMENSIONS ARE IN MM.
2. CHAIN LINK FENCE & FIXING DETAILS INCLUDING MATERIALS FOR THE WORKS SHALL BE AS PER IS: 2721.
3. HTSS WIRE AND CHAIN LINK FENCE SHALL BE ERECTED ONLY AFTER ERECTION OF EACH SEGMENT OF FENCE POST AND STAY POST.
4. CONCRETE / MASONRY TOE WALL SHALL BE PROVIDED BETWEEN FENCING POST.
5. GRADE OF CONCRETE MIX SHALL BE PCC NOMINAL MIX OF 1:1.5:3
6. THE DEPTH OF FOUNDATION SHALL BE TAKEN FROM NGL AND HEIGHT OF STRUCTURE SHALL BE TAKEN FROM FGL.

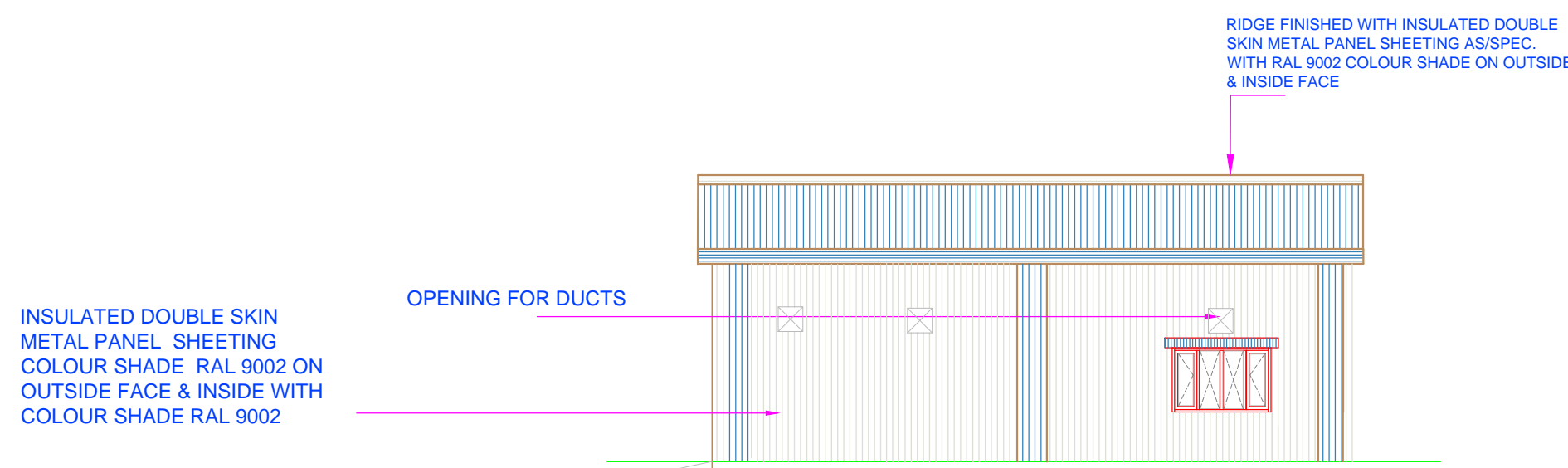
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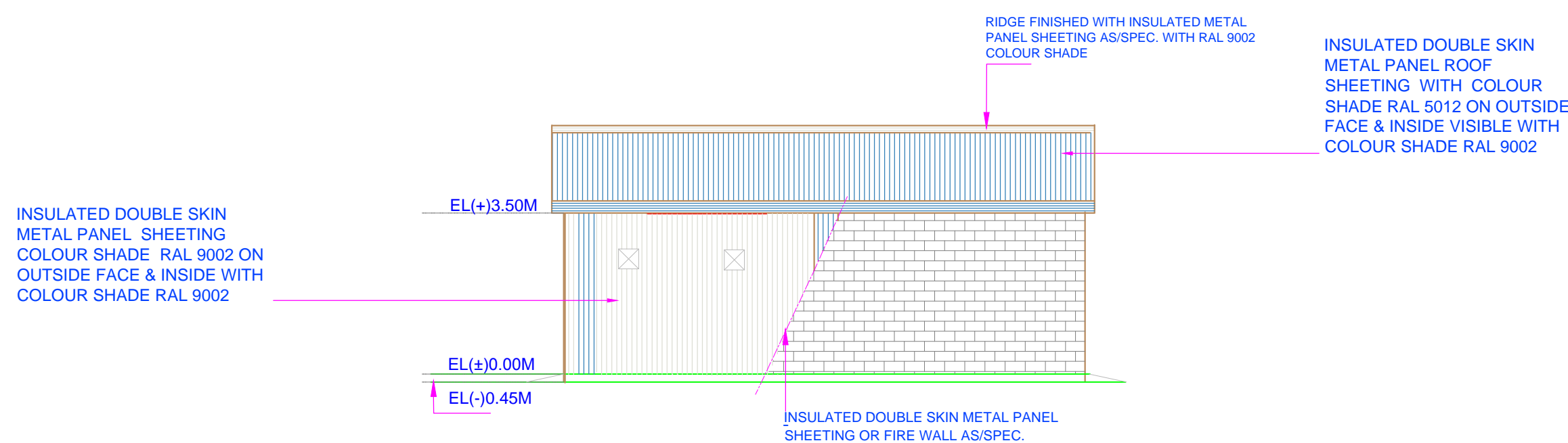
REV. NO. A
5714-004-POC-A-005



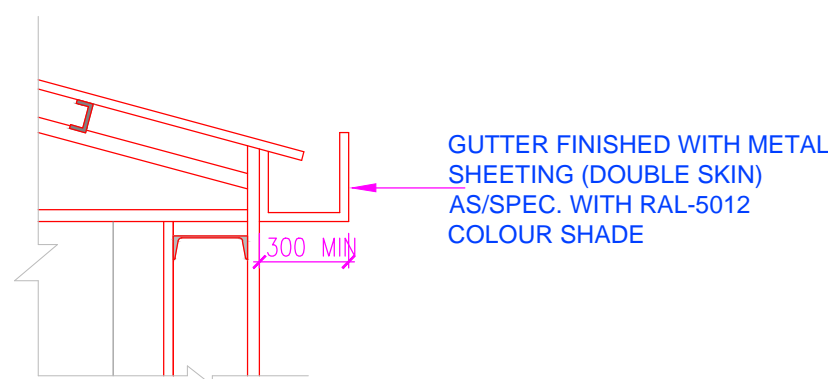
PLAN AT ± 0.0 MTS. LVL.



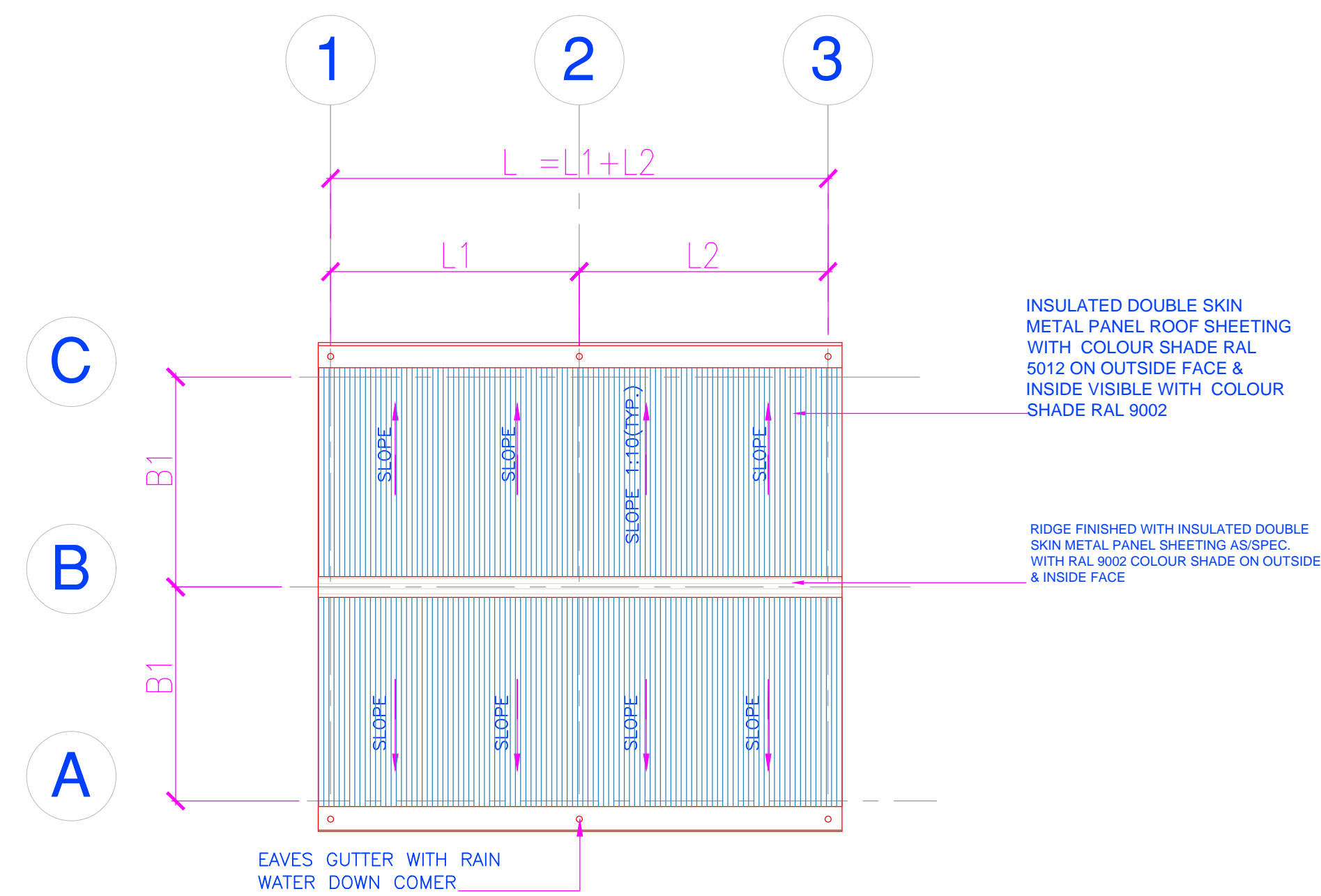
ELEVATION AT P



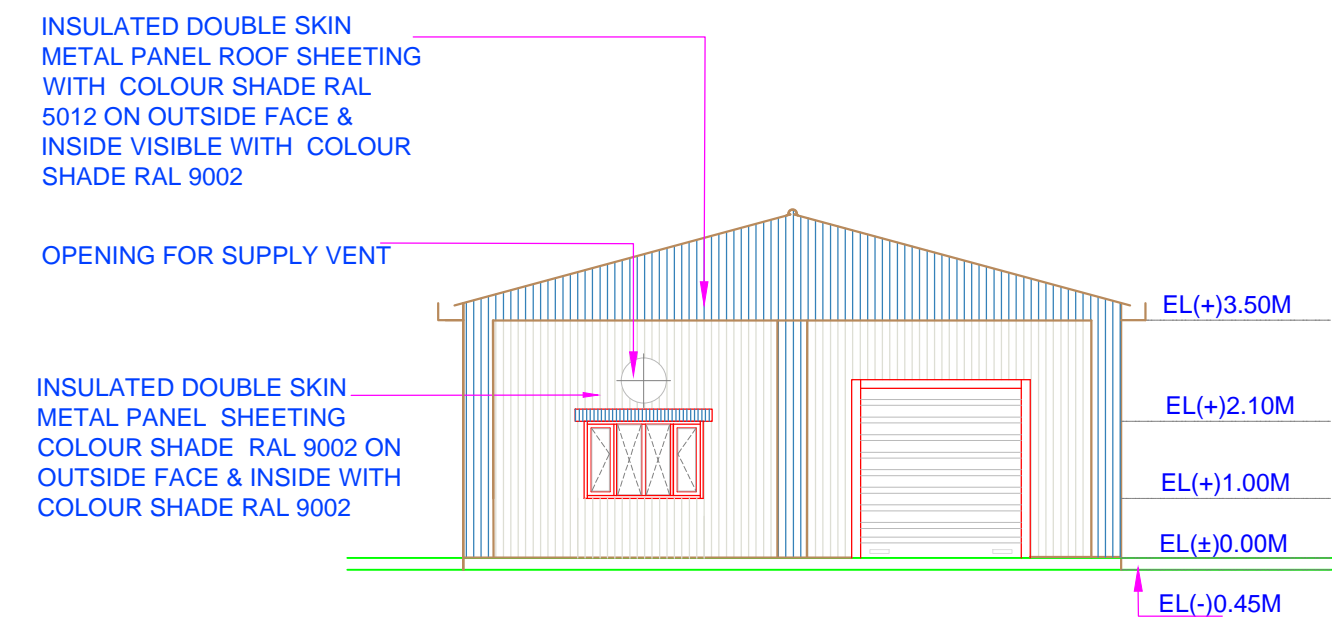
ELEVATION AT R



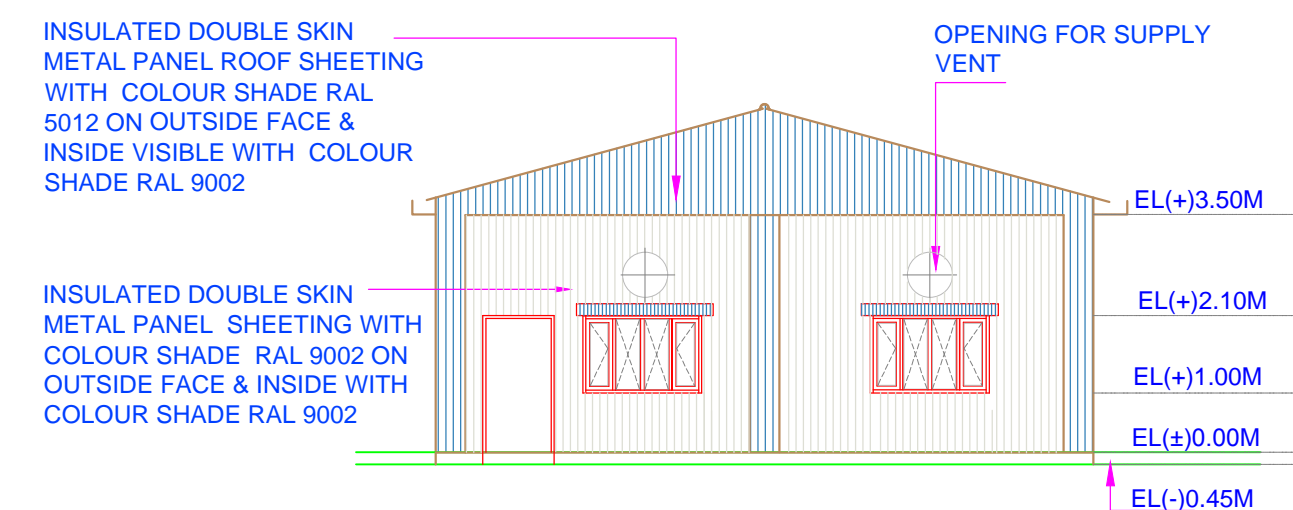
DETAIL AT Y



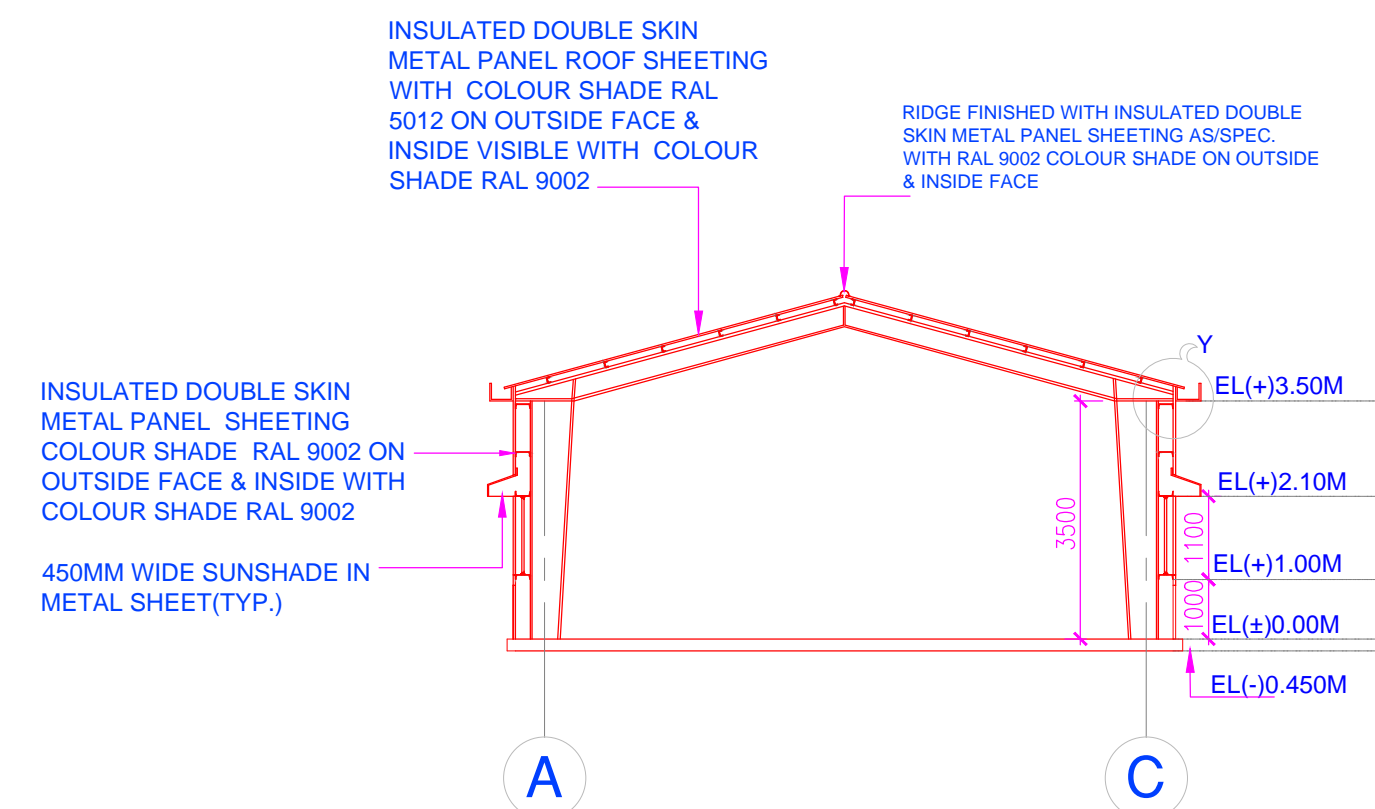
ROOF PLAN



ELEVATION AT Q



ELEVATION AT S



SECTION AT X-X

DOOR/ROLLING SHUTTER/WINDOWS/VENTS/DUCTS				
TYPE	SIZE	CILL LVL.	LINTEL LVL.	DESCRIPTION
D	1200X2100	0.00	2100	
RS	REFER NOTE 5 & 6	0.00	H	
WINDOWS VENTILATORS DUCTS	REFER NOTE 5 AND 6.			

NOTES:-

1. ALL DIMENSIONS ARE IN MM & LEVELS ARE IN METERS.
2. DRAWING SHALL NOT BE SCALED ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.
3. ANY DOUBT OR DISCREPANCY IN THE DRAWING SHALL BE BROUGHT TO THE NOTICE OF THE ENGINEER-IN-CHARGE BEFORE EXECUTING THE WORK.
4. WORK SHALL BE CARRIED OUT BASED ON DETAIL WORKING DRAWINGS TO BE PREPARED BY THE VENDOR & GOT APPROVED FROM NTPC, BEFORE EXECUTION.
5. OPENING FOR ROLLING SHUTTER, DUCT'S AND VENTILATOR'S SHALL BE AS PER INVERTER (PCU) MANUFACTURER RECOMMENDATIONS.
6. LOCATIONS OF DOOR, ROLLING SHUTTER, WINDOWS, VENTS & DUCTS ARE INDICATIVE ONLY.
7. REFER TECHNICAL SPECIFICATION FOR PEB-INVERTER ROOM IN CIVIL WORKS.

REVNO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	APPD.	DATE	SIZE	SCALE	DRG. NO.	REV. NO.
A	RELEASED FOR TENDER PURPOSE ONLY	LDB	LDB	CMV			A1	NTS	5714-004-POC-A-005	A

FOR TENDER PURPOSE ONLY


NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT
DEVELOPMENT OF 250 MW (5X50 MW) SOLAR PV PROJECT
IN MANDSAR DISTRICT OF MP.

TITLE
INVERTER ROOM-PRE ENGINEERED BUILDING
ARCHITECTURE PLAN, ELEVATIONS, SECTION DETAILS




1. ALL DIMENSIONS ARE IN MM AND LEVELS ARE IN METRES.
2. THE LEVEL AT THE TOP OF THE ROAD SHALL CORRESPOND TO THE LEVEL AT THE TOP OF BITUMINOUS CARPET AT THE CENTRE OF ROAD.
3. CAMBER SHALL BE PROVIDED AT SUBGRADE LEVEL.
4. C B R VALUE OF THE SUBGRADE LEVEL SHOULD BE MINIMUM 4%. IF ACTUAL CBR IS LESS THAN 4% IN A PARTICULAR STRETCH THEN THE SAME MATERIAL SHALL MODIFIED WITH INCREASE IN GSB THICKNESS.
5. THE SHOULDERS ON BOTH SIDES OF THE ROAD SHALL BE PROPERLY COMPACTED.
6. THE ROAD SHALL BE MINIMUM 250 MM ABOVE FGL.

	<h1 style="margin: 0;">NTPC Limited</h1> <p style="margin: 0;">(A GOVERNMENT OF INDIA ENTERPRISE)</p> <p style="margin: 0;">ENGINEERING DIVISION</p>				
PROJECT	DEVELOPMENT OF 250 MW (5x50MW) SOLAR PV PROJECT IN MANDSUAR DISTRICT OF MP.				
TITLE	TYPICAL DETAILS OF APPROACH ROADS				
E	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">SIZE A1</td> <td style="width: 25%;">SCALE NTS</td> <td style="width: 50%;"> DRG. NO. <div style="text-align: center; font-size: 1.2em;">5714-004-POC-A-002</div> </td> <td style="width: 25%;"> REV. NO. <div style="text-align: center; font-size: 1.5em;">A</div> </td> </tr> </table>	SIZE A1	SCALE NTS	DRG. NO. <div style="text-align: center; font-size: 1.2em;">5714-004-POC-A-002</div>	REV. NO. <div style="text-align: center; font-size: 1.5em;">A</div>
SIZE A1	SCALE NTS	DRG. NO. <div style="text-align: center; font-size: 1.2em;">5714-004-POC-A-002</div>	REV. NO. <div style="text-align: center; font-size: 1.5em;">A</div>		

[illegible]

PART-J

MANDATORY SPARES

CLAUSE NO.	TECHNICAL SPECIFICATIONS			
1.0	J-1 MANDATORY SPARES			
	<p>The general requirements pertaining to the supply of mandatory spares is as under.</p> <p>(a) The bidder shall indicate the prices for each and every item (except for items not applicable to the bidders design) in the ‘Schedule of mandatory Spares’ whether or not he considers it necessary for the Owner to have such spares. If the bidder fails to comply with the above or fails to quote the price of any spare item, the cost of such spares shall be deemed to be included in the contract price. The bidder shall furnish the population per unit of each item in the Bid Forms and Price Schedules. Whenever the quantity is mentioned in “sets” the bidder has to give the item details and prices of each item.</p> <p>(b.) Whenever the quantity is indicated as a percentage, it shall mean percentage of total population of that item in the station (project), unless specified otherwise, and the fraction will be rounded off to the next higher whole number.</p> <p>(c) Wherever the requirement has been specified as a ‘set’ it will include the total requirement of the item for a unit, module or the station or as specified. Where it is not specified a ‘set’ it will include the total requirement of the item for a unit, module or the station or as specified. Where it is not specified a ‘set’ would mean the requirement for the single equipment/system as the case may be. Also one set for the particular equipment. e.g. ‘set’ of bearings for a pump would include the total number of bearings in a pump. Also the ‘set’ would include all components required to replace the item; for example, a set of bearings shall include all hardware normally required while replacing the bearings.</p> <p>(d.) The Owner reserves the right to buy any or all the mandatory spares parts.</p> <p>(e.) The prices of mandatory spares indicated by the Bidder in the Bid Proposal sheets shall be used for bid evaluation purposes.</p> <p>(f.) All mandatory spares shall be delivered at site at least two months before scheduled commissioning of the solar plant. However, spares shall not be dispatched before dispatch of corresponding main equipments.</p> <p>(g.) Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.</p>			
DEVELOPMENT OF 250 MW (5 BLOCKS OF 50 MW EACH) SOLAR PHOTO VOLTAIC PROJECT(S) IN MADHYA PRADESH		TECHNICAL SPECIFICATION BID DOC. NO: CS-5714-004(R)-9	PART-J	Page 415 of 415