
 <p>बी एच ई एल A4-11</p>	PURCHASE SPECIFICATION SOLAR PHOTOVOLTAIC MODULE	Spec. No	EP:PVM:EQS:01
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**TECHNICAL SPECIFICATION
FOR
TURNKEY SOLAR PHOTOVOLTAIC MODULE
MANUFACTURING LINE
AT
ELECTROPORCELAINS DIVISION,
BHARAT HEAVY ELECTRICALS LTD.,
IISc POST, BENGALURU, INDIA 560012**

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REVISION DETAILS: (00)	PREPARED		DATE
	AK	SM SM	
	APPROVED CNP	ISSUED STG PLNG	03.12.2015

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Introduction

BHEL is inviting tenders for the supply of a turnkey solution for a Solar PV Module manufacturing line. The proposal includes the entire production line along with the associated process auxiliaries as per the scope defined in this specification. The scope includes design, supply, installation, commissioning, technology, line integration, training, process optimization, warranty and Technical Supervision & Maintenance (TS & M) contract and AMC (Annual Maintenance Contract post warranty period) of the turnkey line. Prospective suppliers are required to conform to all the specification and qualification criteria.

Prospective suppliers are required to quote for and supply all the items mentioned in this specification. A package price for the entire turnkey line as per the scope is to be offered and all the specifications shall be supported by detailed technical catalogues and data Sheets of the manufacturer. The location of the turnkey line equipment supply and installation will be at Electroporcelain Division, Bharat Heavy Electricals Ltd., located at Indian Institute of Science (IISc) Post, Malleswaram, Bengaluru, INDIA 560012. The geographical information of the site / plant location, the environmental conditions and site infrastructure details are provided for the information of the bidders in this document.


General Requirements:

The broad indicative configuration and general requirements of the Solar PV Module manufacturing line is described below and the vendors shall configure their offer accordingly. The offered line configuration will be evaluated and certain modifications may be made mutually discussed for the purpose of optimization and standardization during technical evaluation of the bids.

1. The basic configuration of the PV Module manufacturing line shall consist of 2 manufacturing lines each of 50 modules per hour capacity for 72 cells module (alternatively 60 modules per hour capacity for 60 cells module) operating concurrently and together having 100 modules per hour capacity.
2. The approximate plant foot print shall be designed to accommodate both the lines within the provided shop dimensions of 30 x 70 meter approx. with a clear height of 5.5 meters in an existing building.
3. The Solar PV Module manufacturing line shall have flow of work in a linear path and the vendor has to indicate the unit processing time.
4. The off-line equipment provided separately shall be positioned at the nearest possible distance for ensuring minimal physical movement.
5. The Solar PV Module manufacturing line shall have built in buffers for work in process at each of the critical operations for a minimum un-interrupted operational period of 30 minutes for each of the line.
6. The Solar PV Module manufacturing line shall include ease of access for the operators for carrying out operation & trouble shooting, feeding & extraction of process and auxiliary inputs, on-line & off-line maintenance, data access and process supervision.
7. The Solar PV Module manufacturing line shall have full Safety features built in for ensuring total safety to the operators, line equipment and material work in-process. Onboard the equipment, vital points of the line and remote safety / emergency stoppage provision shall be provided at accessible vantage points.

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8. The selection of individual equipment / components for the Solar PV Module manufacturing line shall broadly confirm the broad specification for the major line equipment described in the section 9.
9. The Solar PV Module manufacturing line shall also have provision for segregation of process defects on-line and for interim storage, rectification / rejection without interrupting the automatic operation of the line.
10. The Solar PV Module manufacturing line shall have data acquisition and monitoring at all critical stages from raw material input to finished module output. Vital process parameters thus acquired shall be stored for analysis and product traceability.
11. The Solar PV module manufacturing line is primarily to be configured for maximum automation of the process with minimum human intervention, however the following stages in the manufacturing line is proposed to be carried out manually.
 - a. Bussing or interconnection of strings on module matrix
 - b. Visual inspection & EL Testing before & after lamination
 - c. Junction Box assembly
 - d. Loading of input materials viz., cell stacks, EVA & back sheet rolls, frame elements, sealant etc., at respective stages.


Pre-Qualification Criteria

The turnkey supplier shall necessarily meet the following pre-qualification criteria.

S.No.	Item	Supplier Confirmation
1.	Offer shall be for new equipment and not for any refurbished or used equipment.	
2.	<p>Turnkey bidder shall have the experience of turnkey installations of Solar PV Module Manufacturing line(s)</p> <ol style="list-style-type: none"> i. Of not less than 500 MW cumulative capacity during the period from 01.12.2010 to 30.11.2015, of which there shall be minimum 3 installations of minimum 100 MWp annum capacity. ii. With relevant business presence in India and having a reference of at least one (1) Turnkey Solar PV module manufacturing line installation in India working satisfactorily. iii. The references provided for the above experience shall be successfully and satisfactorily working plants for a minimum period of one year. <p>Documentary evidence for the above shall be provided in the form of the satisfactory certificate issued by the customer, purchase order, commissioning certificate and the performance certificate from the customers.</p> <p>BHEL reserves the right to independently verify the claims and if found to non-conforming and or non-satisfactory, such bids are liable to be rejected at techno-commercial evaluation stage.</p>	
3.	The following six (6) major equipment in the Solar PV Module manufacturing line shall have references of more than 10 installations during the period 01.12.2010 to 30.11.2015. Of these references 5 installations shall be outside the country of origin of OEM and 2 references shall be for the model offered against this tender.	

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	<ol style="list-style-type: none"> 1. Automatic Tabber & Stringer 2. Automatic Layup station with 6 axis robot 3. Electroluminescence Tester 4. PV Module Laminator 5. Automatic Framing Machine 6. Sun Simulator or IV Tester <p>Documentary evidence for the above shall be provided in the form of purchase order, commissioning certificate and performance certificate from the customers. BHEL reserves the right to independently verify the claims and if found to non-conforming and or non-satisfactory, such bids are liable to be rejected at techno-commercial evaluation stage.</p>	
4.	<p>Turnkey supplier shall be the original equipment manufacturer or are their authorized company / organization for at least one of the following process equipment for Solar PV Module manufacturing.</p> <ol style="list-style-type: none"> 1. Automatic Tabber & Stringer 2. Automatic Layup station 	
5.	<p>Turnkey supplier shall take full responsibility for successful integration, performance proving, warranty, TS & M contract, AMC for the entire Solar PV module manufacturing line.</p>	
6.	<p>All the major equipment as mentioned in serial number 3 above shall bear the 'Conformité Européenne (CE)' Marking. The relevant certificates and technical documentation shall be made available in the techno-commercial bid.</p>	
7.	<p>Foreign turnkey suppliers shall have their branch office or an authorized company / organization located in India with requisite number of service engineers / technicians for providing service and support. The authorization letter for the Indian company / organization shall be provided in the techno-commercial bid.</p>	
8.	<p>The turnkey supplier shall obtain undertakings from the OEMs of all the equipment outsourced for the turnkey line for the supply, commissioning, performance and support for the warranty and TS & M contract for their respective equipment. The undertaking document shall be submitted along with the offer. The performance guarantee for the complete line shall lie with the turnkey provider.</p>	
9.	<p>Recent Dun & Bradstreet (D&B) report indicating DUNS number shall be submitted with the techno-commercial offer. If not available, the audited financial statement for the last three (3) years shall be submitted.</p>	

Note:

1. Pre-qualification will be carried out based on the details furnished by the supplier / feedback from their customers / inspection of the company / product if required by BHEL and at its sole discretion.
2. The Pre-qualification criteria are mandatory requirements and the technical bids will be considered only if all the above Pre-Qualification Criteria are met as on the date of techno-commercial bid opening.
3. All supporting documents related to PQC shall be enclosed in the techno-commercial offer.

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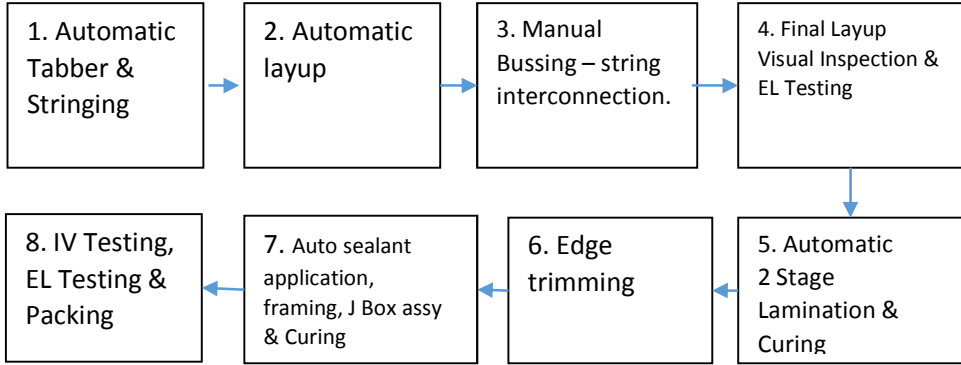
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DETAILS OF TECHNICAL SPECIFICATION FOR TURNKEY SOLAR PV MODULE MANUFACTURING LINE		
S.No.	ITEM	Supplier Confirmation
1.	<p>Scope of supply</p> <p>The vendor scope shall include design, supply, installation, commissioning, technology, line integration, training, process optimization and warranty for the entire manufacturing line for Solar PV Modules to deliver the line performance as per section 2a by providing the turnkey line comprising of the broad equipment summary given in Section 3. The equipment summary is only indicative, other equipment or auxiliary not indicated but required for the manufacturing shall also be included and provided.</p> <p>BHEL scope includes providing requisite utilities viz., electrical supply, compressed dry air, process water, exhaust system and other utilities as per the specification and indication of the turnkey Solar PV module manufacturing line supplier.</p> <p>The Techno-Commercial bid shall clearly bring out the details of scope of supply by the bidders and the details of scope of BHEL.</p>	
2.	<p>Technology</p> <p>The turnkey line shall be based on the conventional glass, backsheets & EVA encapsulated, aluminum framed crystalline silicon cells based solar PV Module manufacturing. The line shall have the capacity for different types of PV cells, glass, encapsulation material and back sheet. The manufacturing line shall also be suitable for glass to glass encapsulation.</p> <p>2a <u>Module line capabilities :</u></p> <p>PV Module size : Upto 2000 x 1000 mm PV Cells Size : 156 x 156 mm PV Cell type : Mono / Multi crystalline Cells PV Cell geometry : Square and Pseudo Square PV Cell thickness : 160 to 250 μm Cell configuration : 60 / 72 cells per module Number of Bus Bars : 3 & 4 (Upgradable to 5 Bus Bar) Encapsulation : UV stabilized EVA Front Glass : High transmission toughened /ARC glass Overall line yield: ≥ 99% (excluding electrical rejects) Technical line availability : ≥ 95% with 24 x 7 operation</p>	

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		<p><u>2b Module Line Capacity Assumptions :</u></p> <p>Plant uptime : $\geq 95\%$ Plant Yield : $\geq 99\%$ Line throughput: Minimum 100 SPV Modules per hour for 72 cell module or 120 SPV Modules per hour for 60 cell module.</p> <p><u>2c Process flow :</u></p> <p>The indicative process flow for the manufacturing of the Solar PV Module manufacturing line shall be as below:</p> <div style="text-align: center;">  <pre> graph LR 1[1. Automatic Tabber & Stringing] --> 2[2. Automatic layup] 2 --> 3[3. Manual Bussing – string interconnection.] 3 --> 4[4. Final Layup Visual Inspection & EL Testing] 4 --> 5[5. Automatic 2 Stage Lamination & Curing] 5 --> 6[6. Edge trimming] 6 --> 7[7. Auto sealant application, framing, J Box assy & Curing] 7 --> 8[8. IV Testing, EL Testing & Packing] </pre> </div>				
3.		<p>Major equipment summary:</p> <p>The equipment must be chosen to deliver the required minimum throughput for each of the station. The detailed equipment specifications are given in section 9. The number of equipment shown is only indicative and may vary according to the throughput of the equipment and line configuration offered.</p>				
Sl. No	Equipment	Technology / Process	No. of equipment per line	No. of equipment for 2 lines	Minimum Throughput per equipment	Vendors Confirmation
1.	Automatic Tabber & Stringer	Automatic sort, pick & place, precise alignment of strings and soldering by IR / Induction method.	02 per line	04 for 2 lines	1800 cells per hour	

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	Equipment	Technology / Process	No. of equipment per line	No. of equipment for 2 lines	Minimum Throughput per equipment	Vendors Confirmation
2.	Automatic Lay-up	By six (6) axis robot with vacuum gripper and programmable matrix layup. To work in synchronization with Tabbers & Stringers and match its throughput.	01 per line	02 for 2 lines	3600 cells per hour	
3.	Auto EVA Cutting & Layup	Automatic measured & programmable cutting and auto layup onto the Glass	01 per line	02 for 2 lines	60 panel & layup per hour	
4.	Bussing Station	Manual bussing & Soldering	6 in-line stations per line	12 in-line stations for 2 lines		
5.	EVA & Back sheet Lay-up Station	Manual EVA & Backsheet lay-up.	03 per line	06 for 2 lines		
6.	Visual Inspection	Visual inspection by mirror reflection or elevating the panel for manual examination.	01 per line	02 for 2 lines	60 modules / hour / station for inspection	
7.	Electro-Luminescence (EL) Tester	CCD Progressive scan with min. 8 Megapixel resolution and 24" display, computer interface for data acquisition and monitoring	1 before lamination & 1 after framing per line	2 before lamination & 2 after framing for 2 lines	60 modules / hour / EL Tester	
8.	Automatic 2 stage laminator	Vacuum Lamination & curing in min 2 stage with thermic fluid heated platens.	02 per line	04 for two lines	30 modules / hour / Laminator	

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	Equipment	Technology / Process	No. of equipment per line	No. of equipment for 2 lines	Minimum Throughput per equipment	Vendors Confirmation
9.	Auto Edge Trimming Station	Gripping and auto trimming	01 per line	02 for 2 lines	60 modules / hour / station	
10	Edge Sealant Application System	Automatic and measured dispensing of sealant into the frame members.	01 per line	02 for 2 lines	Equivalent to 60 modules / hour / system	
11	Automatic Framing Station	Framing of panel laminate in Aluminum sections with corner block punching type securing.	01 per line	02 for 2 lines	60 modules / hour / station	
12.	Junction Box Assembly Station	Automatic measured sealant dispensing, manual fitment and soldering / insertion of Bus Bars	01 per line	02 for 2 lines	60 modules / hour / station	
13.	Hi-Pot Tester	In-line HI-Pot tester for testing of High Voltage and insulation resistance parameters	01 per line	02 for 02 lines	60 modules / hour / line	
14.	Sun Simulator / IV Tester	Xenon / LED lamp light source evaluation of module output with computer interface for data acquisition and monitoring.	01 per line	02 for 2 lines	60 modules / hour / Tester	
15.	Automatic packing station	Pick, overturn, stack and pallet loading of the modules into carton box. Lift and place for transport.	01 system for both the lines		Min 120 modules / hour / station	

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	Equipment	Technology / Process	No. of equipment per line	No. of equipment for 2 lines	Minimum Throughput per equipment	Vendors Confirmation
16.	Automation system consisting conveyors, work stations & buffer storage systems synchronized for automatic movement of modules in process.	Automatic conveying of in process panel / module by power driven roller / belt conveyors with sensing & positioning systems. With necessary guide ways and stoppers for sequential movement and safety against damages. Buffer storage system having auto stacking and releasing as needed.	01 set per line	02 sets for 2 lines	To match above and minimum of 30 minute buffer at all critical stations.	
17.	Controls & Instrumentation system	SCADA system for the entire automated line with computer Interfacing.	01 system per line	02 systems for 2 lines, interconnected.		
18.	Offline Equipment					
A	EVA/Back sheet cutting machine	Automatic measured drawout and cutting	01 per line	02 per 2 lines		
B	Ribbon Cutting machine	Automatic measured draw out and cutting	01 per line	02 per 2 lines		
C	String repair station	Manual	01 per line	02 per 2 lines		
D	Panel repair station	Manual	02 per line	04 for 2 lines		

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4.	Process Utilities by BHEL : The following utilities will be provided by BHEL for the Solar PV Module Manufacturing Line. Other than those described, bidders may indicate their specific requirement.		
	1.	Electrical power <ol style="list-style-type: none"> 1. BHEL will provide 3 phase, $415 \pm 10\% V_{AC}$, $50 \pm 5\% \text{ Hz}$, 4 wire electrical supply to each of the equipment. The Supplier shall provide the specification of the cable and termination type required. 2. All 3 phase machines shall have $415 \pm 10\% V_{AC}$, $50 \pm 5\% \text{ Hz}$, 4 wire arrangement. Single phase machines shall have $230 \pm 10\% V_{AC}$, $50 \pm 5\% \text{ Hz}$, 3 wire arrangement. 3. The Turnkey Line equipment power supply will be routed through a UPS system except for 2 Stage Laminator heating circuit. <p>Bidders shall indicate the electrical power requirement for each of the equipment including the details of power quality, protection features and type of connection.</p>	
	2.	Compressed Dry Air (CDA) <ol style="list-style-type: none"> 1. BHEL will provide the CDA connections up to each of the equipment. 2. Bidders shall indicate the specifications and type of final connections to the equipment. 3. BHEL will provide CDA meeting the following specifications: <ol style="list-style-type: none"> a. Dew point: $\leq -40^\circ \text{C}$ b. Pressure: 7 bar g <p>Bidders may indicate their specific requirement if different from above.</p>	
	3.	Scrubber and Exhaust system <ol style="list-style-type: none"> 1. BHEL will provide the exhaust and scrubbers for the identified equipment as required. 2. Bidders shall indicate the equipment details specifying the positions and connection sizes for all exhaust connections. 	
	4.	Building utilities <p>BHEL will provide air conditioning and other building utilities like air wash system at entry and exit points, fire alarm, Computer Network connectivity, CCTV Monitoring etc.</p>	

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5.	Auxiliary equipment <p>The auxiliary equipment and other support equipment not explicitly mentioned but are required for the functioning shall be provided by the supplier. The following auxiliary equipment shall necessarily be provided.</p>		
5a	Bussing tools including soldering iron and accessories. <p>One set of bussing tools, soldering iron and accessories for each of the manual bussing station and repair stations. The details of tools indicated and its specification shall be provided in the technical bids.</p>		
5b	<p>Laminate storage racks, EVA & Back sheet Storage Racks, Trolleys for manual material movement from one station to other, manual repair station to automated line for string & panel repair etc., as appropriate for each of the line. Bids to indicate the details of such auxiliary equipment offered.</p>		
5c	<p>Laser Cell cutting machine – 1 No, Manual type for reclamation of damaged cells.</p>		
6.	Consumables / Spares <p>The key consumables, equipment spares and wear parts as required for the operation of the line un-interruptedly and must necessarily be maintained in stock for periodic / scheduled maintenance and as necessary for a minimum period of six months shall be indicated in the techno-commercial offer. The item wise description and quantity shall be provided in the techno-commercial offer and the item wise price shall be indicated separately in the price bid.</p> <p>For the warranty period, the responsibility of providing and maintaining the consumables, equipment spares and wear parts rests with the successful bidder.</p>		
7.	Offline Testing equipment <p>The following offline testing equipment required as a part of the product testing, evaluation and quality assurance shall be quoted as optional items. Detailed product catalogues / brochures and technical specifications of the equipment offered shall be provided in the Techno-commercial offer.</p>		
	Sl.No	Description	Quantity
	1.	<p>Environmental Test Chamber (for Thermal cycling test, humidity freeze test and Damp heat test) As per IEC:61215:2005 or latest test standards.</p> <p>1. Thermal Cycling Test : -40 to +85 Deg. C, 50 / 200 cycles 2. Damp Heat Test : 85 Deg. C, 85 % RH, 1000 hours 3. Humidity Freeze Test : -40 to +85 Deg. C, 85 % RH, 10 cycles</p>	01

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	<p><u>Indicative Test Chamber Constructional features & parameters:</u></p> <p>2.1 Test Space Dimensions : 800(W) x 2300(D) x 1200(H) mm</p> <p>2.2 Temperature Range : - 40°C to 85°C</p> <p>2.3 Refrigeration System : Eco-friendly Non-CFC type high efficiency</p> <p>2.4 Temperature Fluctuation : 0.1°C to 1°C</p> <p>2.5 Temperature Gradient : 0.5°C to 1.5°C</p> <p>2.6 Rate of Change (Cooling) : 3°C/Min</p> <p>2.7 Rate of Change (Heating) : 3°C/Min</p> <p>2.8 Humidity Range : 10% to 98% RH</p> <p>2.9 Humidity Fluctuation : 1% to 3% RH</p>	
2.	<p>Mechanical-Load Tester equipment for testing of Solar PV Modules as per IEC 61215:2005 or latest test standard.</p> <p>PV Module of max. size: 2000 (L)*1000(W)*50 mm(T).</p> <p>Pressure to be applied: upto 5400 Pa on the total area of the module</p> <p>With a PLC based control system and HMI control</p> <p>The PV modules placed/ fixed in a fixture, load applied through six numbers of pneumatic cylinders in a modular concept with four vacuum cups each (total of 24 vacuum cups). The vacuum cups position shall be adjustable. The cups shall be controlled by a PLC with all safety factors and limits. (Pressure pads size shall be 80mm dia). Based on the module dimension the load required shall be calculated by the PLC and applied on selected cylinders. The vacuum cups shall cover an area of 2 x 1 metre of the PV Module. The main frame shall be provided with flexible fixing arrangements for the module. PV modules shall be manually reversed for the required cycles of operation.</p>	01
3.	<p>Hipot Tester 5 kV @ 30 mA AC, 5 kV @ 10 mA DC, with built-in Insulation Resistance Tester (upto 1000 V DC) & Continuity Tester along with suitable test table made of extruded aluminum sections in the frame of the equipment with Nylon machined top. Table size: 2100 mm (L) x 1500 mm (W). Working Height: 900mm.</p> <p>High voltage safety curtain with sensors of makes OMRON, P & F, Sick or equivalent.</p>	01
4.	Gel Content Test Setup	01
5.	Solder Peel Strength tester	02
6.	EVA Pull Strength Tester	02

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8.	General requirements for the equipment The turnkey line and its individual stations / equipment offered shall comply with the following general requirements.	
8.1	General construction <ol style="list-style-type: none"> 1. The design & manufacture of the turnkey line equipment shall adhere to appropriate standards for the electrical and mechanical systems to minimize risks to the operators and the equipment. The standards followed for the manufacture of the equipment shall be declared and certification as applicable shall be provided. 2. The equipment must be designed for ease of maintenance and safe accessibility to electrical, electronic and other components. 3. The materials used must be chosen on the basis of the intended working environments, with particular regard to corrosion, abrasion, impacts, extreme temperatures, fatigue, brittleness and ageing. 4. All major equipment shall have the provision for remote fault diagnostics through internet. 5. The computer interfacing for operation, data logging, communication and fault diagnostics wherever required shall be provided with latest operating systems and operating software. Backup of software shall be provided for maintenance purposes. 6. The equipment shall be designed for continuous duty (24 X 7) operation. 7. The equipment shall be aesthetically fabricated and all exposed parts shall be painted with corrosion-resistant paint or coating. The choice of equipment color shall be provided to BHEL. 8. Three hard copies and one soft copy of all the operation & maintenance manuals shall be provided for all line equipment and turnkey line. 9. All the manuals shall be in English language. All the software and operating systems shall be in English language. 	
8.2	Electrical & related Safety requirements <ol style="list-style-type: none"> 1. All machines shall be protected against the risk due to electrical shock and failures with respect to earth fault and residual current. 2. Live parts in the equipment shall be protected by suitable insulation that can only be removed by trained and competent person. 3. The insulation shall be capable of withstanding the mechanical, chemical, electrical, and thermal stresses to which it can be subjected under normal operating conditions. 4. The emergency stop must supersede all modes of operations and functions. There must be no automatic restart of the machine on reset. 	

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8.3	Uninterrupted Power Supply - UPS <ol style="list-style-type: none"> 1. The control systems/PCs/PLCs/conveyors and systems critical for safety shall have provision for supporting by uninterrupted power supply (UPS) for all the equipment. 2. Supplier shall indicate the appropriate rating of the UPS to satisfy the conditions as mentioned in serial number 1 above for all the turnkey line equipment. Providing UPS will be in the scope of BHEL. 3. Load details of the equipment shall be provided for Design of the UPS rating. 	
8.4	Equipment details <p>The technical bid shall include the following information about the equipment and the turnkey line :</p> <ol style="list-style-type: none"> 1. A clear, comprehensive description of the equipment, installation and mounting, and connection to the services instructions. 2. The utility requirements like electric power (voltage, current rating & consumption), compressed air (pressure, quality of air & consumption), Lubrication if required and any other utility for each of the equipment. 3. Wear parts required for each of the equipment and its consumption rate. 4. Information on the physical environment like temperature, humidity, cleanliness level and any other parameter as required. 5. Overview (block) diagrams and schematic wiring diagrams where appropriate. 6. List of recommended support tools. 7. List of suggested personal protection equipment required for safe operation. 8. Dimensions and weight of the equipment. 	
8.5	Marking and Signage <ol style="list-style-type: none"> 1. The system/machine must be marked with all mandatory signage and appropriate warning labels and signs in English language, and identifiers such as marking for electrical shocks, hot surfaces etc. with suitable signage. 2. All machinery must be marked visibly, legibly and indelibly with the following minimum particulars: <ol style="list-style-type: none"> a. The business name and full address of the manufacturer b. Marking of the standard or norm followed for manufacturing c. Serial & model number d. The year of construction, that is the year in which the manufacturing process is completed. 	

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9	Major equipment broad specification and Technical features The major process equipment shall conform to the following technical specifications.	
9.1	Automatic Tabber Stringer : i. Tabber & Stringer machine to Tab and Solder all type of square & pseudo square solar cells of size 156x156 mm ii. Suitable for Mono & Poly crystalline cells. iii. Suitable for 3 & 4 Bus Bars, 5 Bus Bar as optional (with corresponding adjustable space between the bus bars and strings) iv. Suitable for Cell thickness 160 – 250 µm v. Cell Loading System: To have multiple cell loading cassettes for scheduled loading and automatic feeding into the tabber and stringer. The capacity of each cassette and number of cassettes provided shall be indicated. vi. Closed loop Induction/Infrared Soldering or a combination of both with PID controller. The heating and cooling should be progressive and temperature, time adjusting provision should be available. All parameters of soldering process should be able to be chosen individually viz Power / Temperature / Time/ Position/ Speed/ Repeat movement of beam, etc. The soldering quality shall match and exceed the minimum interconnect peel strength of 1.8 N vii. Cell alignment & inspection by Optical method, optical alignment via camera for bus bar as well as edge positioning with an accuracy of ±0.2 mm . Alignment of the cells should be done with respect the busbars on the cell. viii. Cell quality inspection by Optical method via camera and Breakage Detection by backlight as well with a mechanism to sort out the rejected cells. Edge Chip Detection (min 0.5 mm x 0.5 mm) and Internal Breakages/scratches and Cracks ix. Cell spacing min 2 mm x. Interconnect spacing 26 – 78 mm . The pre-set standard sizes may be defined in the technical offer. xi. String length 78 – 2000 mm accuracy in length ±1 mm. xii. Suitable for both leaded & lead free ribbon xiii. Ribbon width 0.8 to 2.5mm & thickness 0.10 – 0.25 mm. with the ribbon positioning accuracy of ±0.2mm . xiv. Flux system: Cells fluxed with adjustable, metered micro spraying technique; top & bottom side selectable. xv. Availability : Min. 95 % xvi. Throughput of the Machine : Minimum of 1800 Cells / Hour / Machine xvii. Cell breakage Max. 0.3 % xviii. Provision should be there to control the throughput / speed of the process of tabbing and stringing in a pre-defined ratio of the maximum throughput. Vendors may indicate the ratio. xix. Suitable provision/tools/jigs should be there for adjusting the different shapes and sizes of the cells, ribbons and the combinations thereof	

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	<p>xx. PREFERRED MAKES OF CRITICAL BROUGHT OUT COMPONENTS :</p> <ul style="list-style-type: none"> a. Servo Drives and Actuators : Rexroth, Siemens, Delta, Festo, Allen Bradley b. Linear Guide ways : THK, Hiwin, Scheeneberger, Parker, Bosch Rexroth c. Sensors : Siemens, Telemecanique, Honeywell, Sick, Omron, Schneider, Keyence, Banner d. Pneumatics : Festo, SMC e. PLC : Siemens, Beckhoff, Allen Bradley, Mitsubishi f. Ball Screws : THK, Parker g. Motors : Oriental, Siemens, ABB, Toshiba h. VFD : Siemens, Danfoss, Mitsubishi, Yaskawa, Delta i. Limit Switches : Schneider, Parker, Delta, j. HMI : Siemens, Mitsubishi, Delta 	
9.2	<p>Layup with Transport System</p> <ul style="list-style-type: none"> i. Automatic pickup of the strings from Tabber and Stringer output and place on the Glass & EVA panel in single stage operation, through a six axis Robot with string pickbar. ii. Throughput to match the number of tabber and stringer output as per the capacity of the turnkey line. Throughput at minimum shall match the rated capacity of Tabber & Stringer. iii. Device should position the strings on a glass panel as per the module configuration in production process. iv. A separate positioning station suitably located within the reach of robot for positioning the strings on the glass panel forms part of the system. The positioning station shall be suitably linked from the glass loading and conveying system. The glass loading system shall be automatic with provision for separating and removing the intermediate paper in the glass stack. v. The layup station shall have provision of buffering the strings in separate buffer trays. Option for in feeding of the buffered / repaired strings via trays should be available. Buffer string trays: Minimum 4 trays to hold minimum of 15 strings capacity shall be provided. vi. Matrix placement accuracy ± 0.8 mm String Gap Accuracy ± 0.5 mm Tab Length Accuracy ± 0.8 mm vii. String Length 1285 – 2000 mm , String bow max 0.5mm viii. Cells per string : 6 to 12 ix. Tab Trimming capability : Tab length 6 – 30 mm x. Glass Size: 2000 x 1100 (max) and 800 x 500 (min). Glass Thickness : 2.4 to 4.0mm xi. Glass Positioning Accuracy : ± 0.3 mm xii. EVA overhang 0 to 10mm xiii. Conveyor direction : bi-directional xiv. Motorized conveyor belt 	

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	<p>xv. Camera assisted alignment of the string</p> <p>xvi. Camera for string inspection system with following features</p> <ol style="list-style-type: none"> a. High Resolution camera min 8 Megapixel b. Front and Backlight imaging and analysis with Software with failure diagnosis. c. The system should be able to Perform the identification of the broken cells, ribbon presence, ribbon misalignment, distance between cells and string dimensions. <p>xvii. Controls Systems.</p> <ol style="list-style-type: none"> a. Computer interfaced. b. HMI / Touch screen Panel. (Language should English) c. Remote Monitoring & diagnostics Via Intranet. d. Data logging and report generation <p>xviii. In the event of a power trip or a mis-event the Layup should come back to the HOME/ START/ZERO position and resume on fault diagnostics and restoration.</p> <p>xix. PREFERRED MAKES OF CRITICAL BROUGHT OUT COMPONENTS :</p> <ol style="list-style-type: none"> a. Servo Drives and Actuators : Rexroth, Siemens, Delta, Festo, Allen Bradley b. Linear Guide ways : THK, Hiwin, Scheeneberger, Parker, Bosch Rexroth c. Sensors : Siemens, Telemecanique, Honeywell, Sick, Omron, Schneider, Keyence, Banner d. Pneumatics : Festo, SMC e. PLC : Siemens, Beckhoff, Allen Bradley, Mitsubishi f. Ball Screws : THK, Parker g. Motors : Oriental, Siemens, ABB, Toshiba h. VFD : Siemens, Danfoss, Mitsubishi, Yaskawa, Delta i. Limit Switches : Schneider, Parker, Delta, j. HMI : Siemens, Mitsubishi, Delta k. 6 Axis Robot : ABB, Kuka, Fanuc 	
9.3	<p>MANUAL BUSSING STATION</p> <ol style="list-style-type: none"> i. The manual bussing station for online interconnection of the strings. ii. The manual bussing station shall have multiple stations - minimum 6 work stations and 2 additional stations for off-line repair per line. iii. Automatic Transport of the glass panels, fix and support them during bussing operation iv. Each bussing station to have independent temperature controlled soldering iron 2 nos per station and accessories, tools and fixtures. i. Belt conveyors with independent motors as required for movement of panel from layup output to each of the bussing station and further transportation of bussed panels to EL Tester. ii. The bussing station to have buffering facility for holding 30 panels in process iii. The bussing station to have rejected panel diversion for manual off-line repair. 	

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9.4	2nd EVA and Backsheet Layup station The station to have independent station with provision for positioning and locking the glass / EVA panel with laid cell string matrix. Manual layup of 2 nd EVA sheet and back sheet with slitting for bus tapping. There shall be 3+3 stations running concurrently to match the turnkey line capacity.	
9.5	Visual Inspection Station The station to have provision for visual inspection of module panel before EL Tester. The visual inspection is done through the reflection in the mirror or by elevating the panel above & person observing from bottom. There Should be two stations for the each of the manufacturing line.	
9.6	ELECTROLUMINESCENCE TESTER The broad constructional feature of EL Tester Should Compose of the following <ol style="list-style-type: none"> i. Aluminum frame structure Dark cabinet. ii. Conveyors for facilitating loading and unloading without disturbing the string matrix on the panel. iii. Electroluminescence Camera with sensor type CCD progressive scan monochrome iv. Sensor Resolution : Minimum 8 Mega Pixels v. Display - The image is displayed on monitors of > 24" in size and should also be made available to reworking stations through a networked display system. vi. Manual power connection to modules. vii. Visual checking of EL image viii. By this image it should be possible to detect common defects such as: Micro-fissures and chips, as well as complete breakage in one or over several cells, Cell impurities, Wafer crystallization defects, Interrupted contact fingers and/or cell breaks that result in an electric separation, General signs of defective cell processing, Shunt Detection & Hot spots. ix. Should be able to test Single Cells, Strings along with the Modules x. Should be able to handle and test the Pre Laminated Panel, Post Laminated Panel, and Framed panel. xi. It should have a software which is user friendly and able to process as well as store the high quality images generated by the EL camera xii. Electroluminescence images of the finished module should be able to be Archived and be able to serve as proof of the delivered quality with respect to the bar coded Serial No of the Module xiii. Suitable for Module of size : Upto 2000 x 1000 mm xiv. Throughput : Min 60 Modules per hour 	

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9.7	<p>Automatic PV Module Laminator - 2 Stage</p> <ol style="list-style-type: none"> i. Should be designed to laminate the PV modules with the usage of Automatic Conveyors ,belts etc. for loading, centering and unloading of the Laminates ii. Module Structure will consist of a Glass Panel,2 EVA Sheets, Solar Cell Strings, 1 layer of Tedlar / Backsheet iii. Indicative Lamination area 2300 mm x 4500 mm per stage (should be able to laminate min 4 panels at a time of size measuring 1000mm x 2000 mm) Max. laminate thickness 15 mm (25 mm beneath of diaphragm) iv. Throughput : Min 30 modules/hour for 60 cell module & 25 Modules / hour for 72 cell module v. Should have 2 different vacuum pumps for both the stages with separate controls for each with 2 more pumps as standby. vi. Different Levels of the Vacuum should be adjustable from the Touch screen / HMI interphase panel for both the stages vii. Vacuum pressure should be achievable 133 Pa in 2min for the first Stage and 10 kPa in 30 sec for second stage viii. Temperature zones : 6 zones for first chamber and 8 zones in second chamber ix. Operating temperature range 30 - 180 °C x. Temperature uniformity $\pm 2^{\circ}\text{C}$ on the platens @150°C, upper chamber opened, no load conditions. (Standard Conditions) xi. Heating rate less than 30min. (from 30°C to 150°C) for the first chamber and less than 90min. (from 30°C to 150°C) for the second chamber xii. Temperature control PID control, Double elements thermocouple (K type) to be installed xiii. Alarm detection Overheat (for each zone), Wire snapping detection system (for each heater) should be provided xiv. Heating Methodology will be through Thermic Fluid electrically heated. xv. Two independent electrical circuits shall be provided for heating and process controls separately (for providing UPS supply only to process controls) xvi. Max. Pressing pressure Programmable, Max. 0.1MPa Programmable, Max. 0.09MPa xvii. Pressing speed 2 steps (Slow, Fast) setting target pressure or time (each 2 speed should be adjustable by manual) xviii. Pre Release sheet Mechanism should be provided xix. Active Pressure Control in Lower chamber xx. External Pump Housing should be provided for One Principal Vacuum Pump and a filter to absorb the EVA gases and fumes etc. xxi. Automatic Cleaning of Melted EVA from the BELT etc. should be available xxii. Standby vacuum pump shall be provided for uninterrupted operation. 	
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9.8	<p>AUTOMATIC SILICONE DISPENSING MACHINE (Sealant Application System)</p> <p>An automatic on-line machine for dispensing measured amount of silicone in aluminium frame slot of the photovoltaic module, basically comprising of</p> <ol style="list-style-type: none"> 1. A Silicone dispensing Station with applicator gun / nozzle. 2. Pumping and pressure control system. 3. Linear guide way with drive for movement of the nozzle along the length of the frame slot, programmable for different lengths and rate of travel and application. 4. Bed with device for holding the frames 5. Maximum length of the frame : 2000 mm 6. The silicone shall be dispensed from bulk drums. Bidders to indicate the capacity of the silicone drum. 	
9.9	<p>EVA / Back sheet Automatic Cutting Machine</p> <p>2 Nos online and 2 no. off-line Automatic film cutting machine for EVA and back sheet. Quick and Adjustable cutting measures Quick Interchange ability of material type Maximum cut measure 2000 length x 1100 width mm.</p> <ol style="list-style-type: none"> i. The cutting and draw speed are adjustable from the touch screen. ii. Automatic piece Counter. 	
9.10	<p>RIBBON CUTTING MACHINE</p> <p>Should be designed to cut leaded / lead free ribbon of variable length and Thickness Automatic drawing of the ribbon from the spool to the desired / programmed length and shearing.</p> <ol style="list-style-type: none"> i. Repeatability of the length cut shall be $\pm 1\%$ ii. Automatic Counter for counting of cut ribbons. iii. Ribbon cutting for width 0.5mm minimum 	
9.11	<p>Automatic Framing Station.</p> <p>A fully automated framing station should perform the following operations: Automatic positioning of the laminated, trimmed and taped module panel, sunny side down, Placement of the four frame section on the pressing plates and automatic profile positioning via proximity sensors, Automatic Centring of the module in the fix reference, Gripping and lifting of the module to the framing level Frame application to the module and punching of the four corners for a tight fit by self-centring devices. It should have the option of adjustable panel dimensions and be able to handle both the 60 cell and 72 Cell Module of maximum size 2000x1000 mm.</p>	

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9.12	<p>Curing Station for assembled PV modules with Silicone Sealant :</p> <p>The bidders have to incorporate PV Module curing station / line for the minimum prescribed time (Approx. 2 Hours). The curing station may have environment controlled for accelerated curing. The curing station could be of tunnel type wherein the modules progressively move and get cured while passing through. The construction details for enclosure, temperature & humidity control and mechanical movement of the modules shall be indicated in the Techno-Commercial offer.</p>	
9.13	<p>Automatic Edge Trimming Station</p> <p>An Automatic Edge trimming station shall be provided in-line in the Solar PV Module manufacturing line.</p> <p>The station shall have suitable gripping and rotating device wherein, the excess overhang of EVA & Backsheet from the module panel to be trimmed automatically with suitable guiding and trimming mechanism.</p> <p>The line shall have suitable mechanism to draw in the module panel into the trimming station and for transferring the trimmed panel onto the next process after trimming.</p>	
9.14	<p>Sun Simulator / IV Tester</p> <p>i. PV module tester for testing of Mono/Multi crystalline silicon solar cell modules under simulated Air Mass 1.5 Global terrestrial conditions. The equipment shall be provided with inline conveyor to facilitate the loading/unloading of the PV module. The equipment shall be interfaced with a computer through user friendly software for testing of the PV module, storage, retrieval and printing of I-V curve data. Tester shall be capable of measuring 72 cell crystalline silicon modules measuring up to 2000 mm x 1000 mm dimension. The typical module parameters are as follows:</p> <ol style="list-style-type: none"> a. Open circuit voltage: 45 Volts b. Short circuit current: 10 Amps. c. Maximum power: 350 W <p><u>Electronic load</u></p> <ol style="list-style-type: none"> i. Precise electronic load shall automatically vary the module load to plot I-V curve. ii. Equipment shall be capable of measuring modules from 80 W to 350 W. iii. Equipment shall be capable of measuring modules with: Open circuit Voltage : up to 60 V, Short Circuit Current: up to 15 A Testing speed: less than 10 seconds & no charging between tests iv. The light source shall be single pulse, LED or Xenon lamp with Triple Class A+ rating. v. Source shall produce AM 1.5 G spectrum for testing under standard testing conditions (STC). The tester shall be able to display and store the following parameters: <ol style="list-style-type: none"> a. Current-Voltage curve b. Power- Voltage curve c. Open-circuit voltage d. Short-circuit current e. Peak Power 	

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	<ul style="list-style-type: none"> f. Current and Voltage at Peak power g. Fill factor h. Series & Shunt Resistance i. Module efficiency j. Module temperature and corrected temperature. k. Date and time of measurement l. Insolation value m. Power & current at set Voltage vi. Module temperature shall be measured during the testing using infrared sensor and the facility for temperature compensated reading shall be provided. vii. IV curve extrapolation capability for different temperature and insolation shall be provided. viii. Automatic calibration capability with reference modules using appropriate software shall be available. Pyranometer / Reference cell coupled to the electronic circuit to monitor illumination intensity and control pulse-to-pulse consistency shall be provided. Tester shall have the interface capability for RFID scanner. The following calibrated PV modules (with test certificate from reputed testing lab) shall be provided with the equipment. <ul style="list-style-type: none"> a) One (1) module with 72 nos. of 156-mm each for mono & multi crystalline silicon solar cells. b) One (1) module with 60 nos. of 156-mm each for mono & multi crystalline silicon solar cells. 	
9.15	<p>Automatic Module Sorting & Packing Station :</p> <p>An Automatic Sorting & Packing station for sorting and packing the PV modules in packing case as per the packing quantity and case parameters programmable. One number sorting & packing station shall receive modules from both the lines for sorting and packing.</p> <p>The throughput of the sorting & packing station: Min 120 modules / hour.</p> <p>The reference dimensions / parameters are as follows :</p> <p>Solar PV Module : 2000x1000x35 mm Number of Modules packed per case : 28 Nos Type of Stacking : Horizontal or Vertical Packing case inner dimensions: 1985x1065x1010 Packing case type : 180 to 469 GSM fluted type (AAA or ACB) carton box seven(7) ply Wooden pallet dimensions: 2020x1105x113 Retainer Strip : Upto 100mm 3 ply The reference drawing for the packing box is attached in Annexure – I</p>	

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10	<p>Technical documentation</p> <p>The following documents have to be submitted with the offer.</p> <ol style="list-style-type: none"> a. The datasheets and catalogues for each of the equipment shall be provided. b. Detailed technical write-up for the integrated turnkey line, schematic diagram and automation features shall be clearly explained indicating movement of modules in the process and the operational parameters at every station. c. A list of all equipment and utility systems containing item description, quantities, make (OEM), model etc. shall be provided along with the offer. d. The turnkey line layout in the identified building and to the dimension indicated shall be provided in AutoCAD format. Additional information on the shop space and building if required any shall be verified by the bidder before submission. e. The turnkey line utility matrix for the production line as well as the auxiliary equipment in supplier's scope shall be provided. f. The price list of all the spare parts for corrective maintenance i.e., parts that are needed to be replaced only in case of malfunction or breakdown shall be provided. g. The price list and quantities of wear parts for one (01) year of preventive maintenance shall be provided. h. The price list of the consumables shall be provided. 	
11	<p>Pre-dispatch inspection</p> <p>The pre-dispatch inspection of the machine will be carried out by BHEL personnel or their authorized representatives at the OEM site with the following conditions.</p> <ol style="list-style-type: none"> a. The supplier shall inform BHEL one month in advance for the inspection date. b. The equipment shall be shown for the completeness in accordance with the specification. c. The design, sizing and utility connections with respect to the drawing shall be shown. d. The equipment shall be operated and the performance parameters specified shall be demonstrated. e. Vendor has to provide requisite consumables / input materials for the purpose of demonstration and proving at their site. f. The safety circuits, alarms and interlocks shall be demonstrated. g. BHEL will bear the expenses for their personnel travel and stay for the pre-dispatch inspection. 	

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12	<p>Packing</p> <ol style="list-style-type: none"> i. The items shall be packed for sea-freight worthiness ii. The design of the packing shall take care of possible damage to the equipment while normal handling and transportation. iii. Packing slips / labels / BHEL PO Reference shall be fixed indicating the items packed inside on each of the box. iv. Each and every box shall be clearly marked indicating the consignee and port of destination. v. Fragile items shall be packed separately with appropriate packing indicating "Fragile" slip outside vi. Packing material used shall be environmentally benign. vii. Provision for inspection windows or ease of accessibility during custom or other verification shall be provided. 	
13	<p>Layout, Moving in and positioning</p> <p>BHEL has provided the production area layout indicating pillar and beam positions, entry door and other features to aid the layout design.</p> <ol style="list-style-type: none"> 1. It is recommended that the supplier may visit BHEL facility prior to submission of offers for better understanding. 2. The available height of the production area is 5.5 meter and that below the beams is about 5.0 meters. 3. The module manufacturing line shall be designed and positioned in the building layout as per the process areas designated in the BHEL drawings. 4. Supplier shall over lay the module manufacturing line in the building layout in AutoCAD format and submit along with the offer for evaluation of foot print. 5. Supplier shall move in and position the equipment and integrate the module manufacturing line as per the layout. 	
14	<p>Installation and commissioning (I&C)</p> <p>Supplier shall complete the following activities and demonstrations for the completion of Installation and commissioning:</p> <ol style="list-style-type: none"> a. The demonstration of properly routed and working utility connections. b. The demonstration of the safety circuits and other safety provisions. c. The demonstration of successful integration of utilities and process equipment in terms of loading of cells and running the process with pre-defined process recipes. d. The demonstration of the working conditions of the offline repair of the module equipment supplied with the line. <p>The demonstration of successful fabrication of the Solar PV Module as per the specified throughput and parameters will complete the installation and commissioning process.</p>	

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	<p>The successful bidder have to depute their competent Technicians / Engineers for carrying out the installation of line equipment, integration of the module manufacturing line, commissioning and proving of the turnkey line. The techno-commercial offer to indicate the number of personnel visiting BHEL and their duration of stay.</p> <p>BHEL will provide assistance for handling of the equipment and associated materials from the store yard on to shop floor along with the requisite material handling equipment. Bidders to indicate in the techno-commercial bid, the requirement of material handling equipment required for installation & commissioning.</p> <p>Any special tools, tackles, instruments, commissioning spares and other materials required for installation and commissioning are under the scope of vendors.</p>	
15	<p>Site Acceptance Test (SAT) SAT will be carried out after the completion of installation and commissioning. Supplier shall complete the following activities and demonstrations for SAT:</p> <ol style="list-style-type: none"> Training: Training of BHEL personnel on the operations, maintenance and troubleshooting of the process equipment, utility systems and metrology tools. Supplier dependent uptime: The demonstration of Supplier-dependent uptime as per section 2a for the entire line. Equipment Throughput: Demonstration of throughput for individual equipment as specified in the tender documents and for the turnkey line as a whole. Quality parameters: The values and uniformity of the values of parameters for Solar PV Modules as per the BHEL PV Module specification shall be demonstrated. Assistance for product certification in line with latest editions of IEC 61215, IEC 61730, IEC 61701 in a third party authorized laboratory shall be provided. Yield of the process: The overall yield of the process shall be demonstrated as mentioned in section 2a. 	
16	<p>Conditions for Site acceptance test</p> <ol style="list-style-type: none"> Observation period: The supplier dependent uptime, throughput and yield of the line shall be demonstrated simultaneously over the observation period of 6 days' on three shift (24 hours) operation. Supplier shall intimate BHEL prior to the beginning of the observation period. The quality parameters may be demonstrated within or prior to the observation period. 	

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17	<p>Materials specifications for achieving the performance in SAT The site acceptance test shall be completed with predefined cells and module materials specifications.</p> <ol style="list-style-type: none"> The turnkey Solar PV Module manufacturing line supplier may recommend the specifications and suppliers for the cells, EVA, backsheet, glass, soldering consumables and other inputs. The materials shall be commercially available and commonly used for the solar cell fabrication. The suppliers recommended for materials shall be regular suppliers to the crystalline solar PV module manufacturing industry for their respective materials. Vendors to indicate the quantity required for SAT well in advance to facilitate BHEL to procure and make it available beforehand. 	
18	<p>Time schedule The bidders shall indicate the supply schedule and activity chart for the installation & commissioning and Site Acceptance Test in the techno-commercial bids.</p>	
19	<p>Warranty</p> <ol style="list-style-type: none"> Supplier shall provide the warranty for a period of 24 (twenty four) months from the date of completion of I&C or 30 (thirty) months from the date of receipt of all items and consumables, whichever is earlier. The warranty shall cover all the essential spares and wear parts for the entire warranty period. The spare and wear parts needed for the smooth operation shall be stocked locally/at BHEL sufficient for a period of 6 (six) months and shall be replenished. There shall not be any interruption of production due to want of spare and wear parts. All the preventive maintenance tasks defined in the TS & M contract shall be performed during the complete warranty period as well without any extra payment. During the warranty period, the responsibility of providing and maintaining the consumables, equipment spares and wear parts rests with the successful bidder & turnkey line supplier. 	
20	<p>Technical Supervision & Maintenance (TS&M) Contract:</p> <ol style="list-style-type: none"> The Turnkey supplier shall agree for providing “Technical Supervision & Maintenance (TS & M)” services for the turnkey Solar PV Module Manufacturing line. The TS & M contract shall be for a minimum period of 2 years from the date of 	

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 <p>बी एच ई एल CBU - EPD</p>	PURCHASE SPECIFICATION FOR SOLAR PHOTOVOLTAIC MODULE MANUFACTURING LINE	Spec. No	EP-PVM-EQS-01
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	<p>successful commissioning of the system.</p> <p>c. The purpose of TS&M contract and the scope is provided in Annexure – II</p> <p>d. For the purpose of TS & M contract, the vendor has to depute their trained / skilled technicians round the clock throughout the year. (At least one technician per shift in the 3 working shifts per day)</p> <p>e. For general overseeing the turnkey line and equipment operation, parameter setting and modification, programming and other equipment monitoring and maintenance a trained supervisor / engineer shall be deputed who can be present during the day shift.</p> <p>f. The general terms and conditions of the TS & M contract governing the deployment of the vendors personnel at BHEL is provided in Annexure – II</p> <p>g. All the preventive maintenance tasks defined and recommended by the OEM's shall be performed during the warranty period and is part of the TS & M contract.</p>	
21	<p>Comprehensive Annual Maintenance Contract (AMC)</p> <p>a. The Turnkey supplier shall agree for providing comprehensive AMC for all equipment for a period of three (03) years after the expiration of warranty period.</p> <p>b. AMC shall cover labour, spare and wear parts for the entire period of AMC.</p> <p>c. The price for comprehensive AMCs for three (03) consecutive years after the warranty period shall be quoted. The AMC value will be considered for arriving at the lowest bidder.</p> <p>d. All the maintenance checks and activities to be performed at quarterly and annual basis as per the 'Maintenance Schedule' provided for each equipment shall be completed by the service engineer during the visit to BHEL in assistance with BHEL personnel.</p> <p>e. The service engineer(s) shall be deputed as and when required by BHEL within 24 hours of notification during the remaining AMC period.</p>	
22	<p>General Terms & Conditions:</p> <p>i. The commercial terms of this tender shall be applicable for the future purchases of the spares/consumables/sub-systems and consumables for the equipment to be procured from the supplier.</p> <p>ii. Supplier shall confirm adequacy of the equipment and accessories quoted for the intended use of turnkey line. Any other requirement shall not be entertained later.</p> <p>iii. Any deviation from the BHEL specification shall be clearly brought out. Otherwise, it is understood that BHEL specification is accepted in total and there is NIL deviation.</p> <p>iv. Supplier shall keep BHEL indemnified against any damage during installation, commissioning, repairs and maintenance of the equipment. Personnel deputed at BHEL shall be covered by relevant statutory provisions of the ESI/Workmen compensation Act or other acts as applicable.</p>	

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