Annexure – I

Design, Fabrication, Supply, Installation and Commissioning of Automated Prepreg Cutting Machine

1. Introduction:

Composites Entity of VSSC has been using latest technologies for the development of composite structures and thermal protection systems. The basic raw materials are carbon-phenolic, silica-phenolic, carbon-epoxy and glass-epoxy prepregs. These prepregs are available in 900 - 1200 mm width and 50 - 90 m length (approx.) as a roll / spool. The prepreg is as 2D woven / UD material (carbon / silica / glass) impregnated with phenolic/epoxy resin system. List of prepreg materials to be cut using the machine are mentioned below:

Sl. No.	Material	Thickness (mm)
1	Carbon Phenolic Prepreg	0.35 - 0.45 mm
2	Silica Phenolic Prepreg	0.65 - 0.75 mm
3	Carbon Epoxy Prepreg	0.15 - 0.25 mm
4	Glass Epoxy Prepreg	0.15 - 0.25 mm

Thickness may vary up to 2 mm, due to folding / wrinkles in the prepreg. The automated prepreg cutting machine shall be of heavy-duty type and capable of cutting the prepreg in wet or dry conditions. The machine and its operating system shall include cutting software as well as pattern making & nesting software to optimize the cutting pattern ensuring optimum utilization of raw material without compromising on quality and safety.

2. Scope of work:

2.1. Scope of work by the party shall include following major activities:

2.1.1. Design of computer-aided automated prepreg cutting machine as per the specifications mentioned in this document.

2.1.2. Presentation of the design of prepreg cutting machine and layout drawing to the preliminary design review (PDR) committee constituted by VSSC.

2.1.3. Fabrication of automatic prepreg cutting machine and its subsystems.

2.1.4. Testing and calibration of the machine as per standards.

2.1.5. Delivery of Automatic Prepreg Cutting Machine and its subsystems / accessories to CMSE/VSSC Trivandrum, Kerala including transportation, unloading and positioning of the same at the identified location.

2.1.6. Supply of various auxiliary systems like air compressor, UPS, servo controlled voltage stabilizer with noise cutoff ultra isolation transformer, etc. required for operation of prepreg cutting machine.

2.1.7. Installation, demonstration of features/capabilities and commissioning of the machine at CMSE/VSSC.

2.1.8. The party shall take up the activity as a turnkey project and all the required works for satisfactory commissioning of the machine shall be under the scope of party. However, VSSC will provide support and services as mentioned below.

2.1.9. The automated prepreg cutting machine shall be an end-to-end system with all necessary hardware and software required for cutting of prepreg as per the designed pattern. The input to the system will be 2D drawings generated in AutoCAD / Inventor.

2.2. Supplies and services provided by VSSC shall include:

2.2.1. Power supply: Power supply connection will be provided near to the prepreg cutting machine. The power supply voltage shall be of 415+-10% AC, 3 phase, 50 Hz. Party shall route the required cables from this spot to the machine.

2.2.2. Civil engineering works: The civil engineering works will include providing foundation, if required, trenches, slabs etc., for enabling the party to lay the pneumatic lines and power cables. However, party shall provide details of these requirements during preliminary design review.

2.2.3. Water supply: The water supply will be provided up to water sump location. Party shall route required water pipelines from this point to the machine subsystems, if required.

2.2.4. 10 T / 5 T overhead crane with 12m hook height will be provided for unloading and handling of machine subsystems. Consignments weighing more than 10T shall be unloaded and handled using appropriate capacity cranes and the same shall be arranged by party.

2.2.5. Storage space for all the machine subsystems for a nominal period from the date of delivery till installation.

2.2.6. Providing prepreg (carbon-phenolic, silica-phenolic, carbon-epoxy and glass-epoxy having different thickness) for machine demonstration of cutting operations at VSSC.

3. Detailed technical specifications:

The automated prepreg cutting machine shall have following subsystems.

- Prepreg & Polythene / Release Film Unwinding Unit
- Bristle Cutting Bed
- Cutting Head
- Cut-Prepreg Collecting Conveyor
- Vacuum System
- PC based Operator Console with Cutting Software
- Pattern Making and Nesting Software with High end workstation
- Auxiliary Systems

4. Prepreg & Polythene / Release Film unwinding unit

4.1. The prepreg (carbon-phenolic, silica-phenolic, carbon-epoxy and glass-epoxy) is as 2D woven / UD material (carbon / silica / glass) impregnated with phenolic/epoxy resin system. It will be available in 900 - 1200 mm width and 50 - 90 m length (approx.) as a roll / spool. Spool will have diameter of 800 mm (approx.) and weight of 150 kg (max.).

4.2. Prepreg spool shall be held by air shaft of diameter 6 inch.

4.3. Loading and unloading of prepreg spool shall be done manually.

4.4. Web aligner mechanism working in closed loop shall be provided for the alignment of edges of the prepreg in the cutting machine.

4.5. Automated tension control mechanism shall be provided for the prepreg rolls.

4.6. Unwinding unit shall also facilitate the mechanized removal of polythene film / release film from the prepreg during unwinding.

5. Bristle cutting bed

5.1. The cutting / working bed area shall be 1700 mm length (nominal) and 1250 mm width (minimum).

5.2. Cutting / Working bed shall essentially have bristle blocks for effective vacuum communication preferably from bottom side. These bristle blocks shall be easily removable for cleaning and replaceable.

5.3. Bristle block shall be preferably in red color for easy recognition of prepreg spread on the cutting bed. These bristle blocks shall not chemically react with the prepreg.

5.4. Size of the bristle blocks shall be specified by the party in their offer.

5.5. Belt conveyor movement shall be synchronized with pick-up of cut prepregs i.e. the cutting shall not take place while conveyor advances and once the conveyor movement is stopped the cutting shall resume.

5.6. A suitable width-reducer shall be provided for arresting vacuum through the remaining bristle blocks depending on width of prepreg to be cut.

6. Cutting Head:

6.1. The machine shall have feature of high speed cutting head with drag type blade system. It shall also have a laser pointer to set the reference or cutting area.

6.2. Cutting head shall move on gantry beam guided using rack & pinion mechanism (X & Y axis). Safety bars shall be mounted on both sides of the gantry beam.

6.3. The Cutting head unit shall have blade mounted under pneumatic pressure of minimum 5 bar. A pressure gauge shall be mounted on the cutting head to read working pressure.

6.4. It shall be capable to continuously vary cutting speed from 10 to 80 m/min or better, with positioning accuracy of ±1 mm or better.

6.5. It shall cater to the maximum cutting thickness of 2 mm.

6.6. The machine shall have automatic cooling system for controlling blade temperature. It shall also have blade breakage detection features.

6.7. The cutting head shall be provided with visual windows.

6.8. Blade shall be preferably made of Titanium material. Party shall specify material and geometry of blade in their offer.

7. Cut-Prepreg Collecting Conveyor

7.1. Cut-prepreg shall be picked-up by a collecting conveyor.

7.2. The collecting conveyor area shall be 1500 mm length (nominal) and 1250 mm width (minimum). Width of unloading conveyor and cutting bed shall be same and in same level / plane.

7.3. The collecting conveyor unit shall have speed of 5 – 10 m/min.

7.4. It shall not chemically react with the prepreg.

7.5. It shall be easily cleanable.

8. Vacuum System

8.1. Prepreg shall be held in cutting bed area through vacuum application, during cutting as well as movement of collecting conveyor.

8.2. A dry vacuum pump shall be selected to provide uniform vacuum in the cutting bed area to the level of 300 mbar pressure or better.

8.3. A dry vacuum pump of make M/s. Pfeiffer / Busch / Edward / Leybold / MKS shall be provided in the machine. Party shall specify vacuum pump details like make, model no., capacity etc. in the offer. Suitable manifolds, valves etc. shall also be provided for connection to the machine.

8.4. The system shall have control system to enable different vacuum levels for cutting of different type of materials.

8.5. A vacuum gauge shall be mounted in the machine for monitoring the vacuum level in cutting bed area.

9. PC based Operator Console with Cutting Software

9.1. The operator console shall consist of a PC based control system preloaded with cutting software. This operator console unit shall be mounted on a separate stand.

9.2. The cutting software shall be compatible with output file format generated by pattern making and nesting software.

9.3. The cutting software shall also be provided in a separate storage device like DVD /CD / pen drive, to enable reloading.

9.4. Various machine parameters like vacuum level, prepreg dimensions (width and length), cutting speed, cutting pressure, conveyor movement, no. of plies to be cut etc. shall be set through operator console.

9.5. The operator console shall be user friendly and shall have features like interactive menu driven format, remote diagnosis etc. Display of real time cutting with progress bar shall be displayed on screen.

9.6. Error messages / notifications / alarms etc. shall be displayed in English language.

9.7. The control console shall have feature to save different set of machine parameters of prepreg cutting for future recall/use.

9.8. Essential interlocks shall be incorporated in the control console for safety of operator as well as machine.

9.9. The operator console unit shall be properly protected from dust, fiber, resin etc.

9.10. Emergency stop button shall be provided near to the operator console.

9.11. The PC based operator console shall have following configuration:
Intel's i9 core or latest processor; 16 GB RAM, 256 GB SSD; 1 GB Graphic Card; 4 nos. of USB port; CD-ROM; CD/DVD writer; 21" touchscreen display, Keyboard, optical mouse; Microsoft's Windows 11 or latest operating system; antivirus software.

10. Pattern making and nesting software with High end workstation

10.1. Pattern making and nesting software shall be preloaded in a high-end workstation. The software shall also be provided in a separate storage device like DVD /CD / pen drive, to enable reloading in to the same workstation or in a different workstation.

10.2. Pattern making software shall enable design / drafting of required 2D complex profiles. It shall also have feature for calculation of material requirement for any product.

10.3. Nesting software shall automatically arrange prepreg cut pieces in optimized way considering the fabric direction & ensuring maximum usage of prepreg.

10.4. It shall have interactive menu driven format and shall be user friendly.

10.5. It shall be compatible with the commercially available drafting software like AutoCAD, ProE, CATIA, Inventor etc. and with all universal file formats for pattern/drafting.

10.6. The high end workstation for pattern making and nesting software shall be a separate unit and not be attached with operator console. It shall have following configuration: Intel's i9 core or latest processor; 16 GB RAM, 256 GB SSD; 1 GB Graphic Card; 4 nos. of USB port; CD-ROM; CD/DVD writer; 24" or higher LED Monitor, Keyboard, optical mouse; Microsoft's Windows 11 or latest operating system; Antivirus software.

11. Auxiliary Systems:

Auxiliary systems of reputed make, as listed below, shall be provided along with the machine. Details like model number, capacity etc. of these items shall be specified in the offer.

11.1. **Air Compressor:** An air compressor shall be provided to supply pneumatic air for holding the cutting blade and to operate valves available in the machine. The air compressor shall be of make - M/s. Chicago Pneumatic / Ingersoll Rand/ Atlas Copco and, minimum capacity as - output pressure: up to 10 bar; flow rate: 50 cu.ft/min.; motor power: 15 HP.

Suitable manifolds, pneumatic lines, filter etc. shall also be provided for supply of air to the machine.

11.2. **UPS:** An Online UPS of 5 KVA or better rating with at least 30 minutes backup time shall be provided for the control system and operator console of machine. The UPS shall be of make – M/s. APC / Microtek / Vertiv / Schneider / Numeric.

11.3. **Servo Controlled Voltage Stabilizer with Noise Cutoff Ultra Isolation transformer:** It shall be provided for safety of the machine. It shall be of make – M/s. Servomax / ABB / Neelkanth and, minimum capacity as – power: 50 kVA 3PH and output voltage: 415 V AC.

12. Spare Cutting Blade:

Party shall supply 150 numbers of cutting blade as spare.

13. Input power and environmental conditions:

The machine shall be operated under following conditions at CMSE/VSSC:

- Input power supply: 415V ±15% AC, 50 Hz, 3 phases
- Ambient temperature: 20 to 40 deg C
- Relative Humidity: 30 to 80 %

14. PDR (Preliminary Design Review)

14.1. Party shall carry out preliminary design of the prepreg cutting machine and prepare a preliminary design document containing details of all the subsystems and necessary safety features for operator & machine. The layout drawing shall include details on floor space, foundation, power cable routing etc. for installing the machine.

14.2. Within **one month** from the date of receipt of purchase order, the party shall present preliminary design document and layout drawing to VSSC for review and clearance.

14.3. All the modifications, as suggested and agreed upon in PDR, shall be incorporated in the document and implemented in the respective subsystems by the party.

14.4. Final design document and layout drawing shall be submitted to VSSC for clearance of preliminary design.

14.5. The party shall start the fabrication activities after obtaining clearance for preliminary design of the machine.

15. Pre-delivery inspection (PDI)

15.1. VSSC representatives will carry out pre-delivery inspection of the machine systems at party's site. The party shall intimate VSSC, 4 weeks in advance, regarding readiness for pre-delivery inspection.

15.2. During PDI, the party shall produce documents/reports/certificates confirming the specification, design, drawings, testing, calibration etc. wherever necessary. All the features and operational capabilities of the machine shall be demonstrated by party.

15.3. Conformance to machine specifications with regard to component / subsystem / system shall be verified by the VSSC representatives during PDI.

15.4. During PDI, any recommendation by VSSC for modification shall be mutually discussed and the same shall be incorporated by the party. After verification of modifications, if any, clearance will be given for dispatching the machine systems.

16. Delivery, Installation and commissioning

16.1. Within **one month** from the date of receipt of purchase order, the party shall present preliminary design document and layout drawing to VSSC for review and clearance.

16.2. Delivery, installation and commissioning of the machine shall be completed **within ten months** from the date of clearance of preliminary design.

16.3. The offer from party shall clearly indicate the delivery schedule identifying the date for various milestones like submission of preliminary design document & layout drawing, pre-delivery inspection, delivery of items to CMSE/VSSC, installation and commissioning.

16.4. The machine shall be installed and commissioned at CMSE/VSSC, Trivandrum, Kerala.

16.5. Necessary manpower, handling equipment, personnel protective equipment etc. required for the installation shall be arranged by the party. Qualified and experienced personnel shall be deputed for activities at VSSC.

16.6. The commissioning shall include demonstration of all the features & operational capabilities of the machine including programming of cutting templates. Cutting shall be demonstrated on prepreg (carbon-phenolic, silica-phenolic, carbon-epoxy and glass-epoxy having different thickness) supplied by VSSC.

17. Training

17.1. During and after installation of the machine, party shall provide training to VSSC's technical personnel in all respects regarding normal machines operations, cutting software usage, cutter replacement, emergency shutdown procedure, safety precautions, maintenance aspects etc.

17.2. Party shall also provide training on pattern making & nesting software for design/drafting of templates and its arrangement within a given workspace.

17.3. Party shall confirm on providing periodical training regarding update in the software/hardware after commissioning, without any extra cost.

18. Documents

The party shall provide hard copy of following documents in English language, to VSSC.

18.1. <u>Documents after PDR (Preliminary Design Review) clearance</u>:

18.1.1. Final Design Document as cleared by PDR (Preliminary Design Review) committee of VSSC.

18.1.2. Layout drawing indicating details on floor space, foundation, power cable routing etc. for installing the machine.

18.2. <u>Documents along with supply of machine</u>:

18.2.1. Three sets of documents / manuals regarding Operation, Maintenance (Mechanical, Electrical, Electronics, Controls) and Safety procedures.

18.2.2. Three sets of documents/reports/certificates confirming the specification, design, drawings, testing, calibration etc. wherever necessary.

18.2.3. List of essential spares and consumables to be maintained by VSSC for trouble-free operation of the machine.

18.2.4. A catalogue of spare parts which shall contain details like part list, part drawing etc.

19. Software License

The software license shall be in the name of **Vikram Sarabhai Space Centre** and shall have life time validity. Any update of the software (cutting software as well as pattern making & nesting software) within warranty period shall be provided to VSSC without any extra cost.

20. Warranty

Party shall provide warranty for a period of two years for the entire system from the date of successful installation and commissioning at VSSC.

21. Annual Maintenance Contract (AMC)

Party shall offer AMC for 3 years after warranty period. In addition, assured comprehensive support for the maintenance and service including the supply of spares, consumables and software updates for a period of minimum ten years after warranty period shall be confirmed by the party.

22. Terms & Conditions

22.1. <u>Vendor Qualification</u>: The party must have supplied minimum three numbers of automated **prepreg** cutting machine in last five years to different customers among which at least one supply & installation should be in India. Details of such works executed in the recent past by the party along with contact details of customers shall be submitted in technical bid. If any activity is done at ISRO/DRDO/CSIR/HAL or any Indian PSUs, the same shall be highlighted.

22.2. The party shall submit the quote on two-part basis – (1) Technical Bid, and (2) Price Bid with cost split-up.

22.3. **As part of technical bid, party shall submit the following**:

22.3.1. Compliance statement against each of the points as per given format.

22.3.2. Detailed catalogue of similar machines with model no.

22.3.3. List of essential spares and consumables.

22.3.4. AMC details without cost.

22.3.5. Party's experience in supply & installation of automated prepreg cutting machine.

22.4. The technical bid from the party **shall not contain price** of any of the item including AMC, failing which the party shall stand disqualified from participating in the tender and their price bid will not be opened.

22.5. **As part of price bid, party shall submit the following**:

22.5.1. Quotation for the machine with cost split-up in following format as a separate pdf document.

Particulars / Description	Cost	Tax
Design and Fabrication		
Pattern Making and Nesting Software with High End Workstation		
Auxiliary Systems (Air Compressor, UPS, Voltage Stabilizer)		
Spare Cutting Blades – 150 nos.		
Packing & Forwarding		
Supply (Loading, Transportation and Unloading)		
Installation and Commissioning		
Total		

22.5.2. Quotation for cost of spares and consumables as a separate pdf document. The quote shall remain valid for 3 years from the date of commissioning of the machine.

22.5.3. Quotation for AMC charges for a period of three years after warranty period as a separate pdf document.

22.6. Entering into an AMC with party is the sole discretion of VSSC, i.e., VSSC may or may not enter into an AMC with party. AMC charges will not be considered for arriving at L1 party.