



INDIAN INSTITUTE OF TECHNOLOGY BOMBAY
MATERIALS MANAGEMENT DIVISION
 Powai, Mumbai 400076.

(PR No. 1000055602)

(Rfx No. 6100003031)

Technical Specification for:
Thermal and Vacuum Cycling Chamber (Thermovac)
 SITARE Lab, Department of Physics, IIT Bombay

1. Overview

1.1 Preamble

The Space Instrumentation and Technology for Astrophysics Research Laboratory (SITARE Lab) at the Department of Physics, Indian Institute of Technology Bombay, is engaged in advanced research in space science and technology. SITARE Lab leads the Daksha mission – a high-energy space telescope being developed for the Indian Space Research Organisation (ISRO) – and mentors IIT Bombay's student satellite programme.

SITARE Lab aims to procure a Thermal Vacuum (Thermovac) chamber for its test and qualification capability for space payloads. IIT Bombay therefore invites bids for the procurement of a custom Thermal and Vacuum Cycling Chamber to be installed at SITARE Lab. The facility will be used by SITARE Lab research staff, IIT Bombay students as part of space-technology training programmes, and by external users from academia and the space industry for a wide range of space and non-space applications.

This tender specifies the design, fabrication, supply, installation, testing and commissioning requirements for the Thermovac chamber system, including all ancillary equipment, instrumentation, software and civil interfaces required for a fully operational facility.

1.2 Technical Contacts

All technical queries shall be directed to the following contacts at IIT Bombay:

Name	Department / Role	Phone	Email
Varun Bhalerao	Associate Professor, Dept. of Physics, IIT Bombay	+91-22-2576 9379	varunb@iitb.ac.in
Sairam Chenna	Project Staff, Dept. of Physics, IIT Bombay	+91-22-2159 6543	30006731@iitb.ac.in

1.3 Tender Evaluation Process

Evaluation of all proposals will be done by a committee to be constituted by IIT Bombay. The technical proposal will be evaluated on the various grounds.

Sr. No.	Eligibility Criterion
1	Bidder/OEM should have experience in thermal & vacuum systems installation for at least 5 years
2	Bidders should have a Minimum Average Annual Turnover of at least ₹ 2 Crores for the past three financial years, i.e., 2023-24, 2024-25 and 2025-26
3	OEM should have a Minimum Average Annual Turnover of at least ₹ 13 Crores for the past three financial years, i.e., 2023-24, 2024-25 and 2025-26
4	Bidder/OEM must comply with all detailed technical specifications
5	Bidder must have supplied at least 3 thermal and vacuum chambers to Indian space institutes or industries

1.4 Presentation

The vendor shall make a detailed presentation covering the following points:

- Company overview
- Services and products developed by the bidder / OEM
- Overview of past thermal and vacuum systems developed and installed by the company in India
 - Number of units supplied
 - Capabilities of the units supplied
 - Contact details of the corresponding customers / users
- Any other details deemed relevant to the tender
- Technical specifications proposed by bidder for this IIT Bombay system
 - Detailed design
 - Materials and components used
 - Overall timeline
 - Supply and installation process
- Details of warranty, after-sales service, annual maintenance contract options, escalation matrix
- All other details asked for in the bid document

Vendors who fail to make a presentation or do not provide satisfactory answers to queries from the committee shall be rejected.

Tender Evaluation Process

Evaluation of all proposals will be done by a committee to be constituted by IIT Bombay. The technical proposal will be evaluated on the various grounds.

1. Eligibility Criteria: Fulfilment of all conditions stipulated under Section 1.3 of the tender document.
2. Presentation: Submit and deliver the presentation as specified under Section 1.4.
3. Technical Compliance: Ensure full compliance with the technical specifications and requirements outlined in Section 3.
4. Other Terms and Conditions: Compliance to all additional terms and conditions as prescribed in Section 4 of the tender document.

2. LIST OF ABBREVIATIONS

Abbreviation	Full Form
AMC	Annual Maintenance Contract
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CAD	Computer-Aided Design
CF	ConFlat (UHV flange standard with metal gasket seal)
DAS	Data Acquisition System
DUT	Device Under Test
FAT	Factory Acceptance Test
FR	Filter-Regulator
GCC	General Conditions of Contract
GUI	Graphical User Interface
HEMSLD	Helium Mass Spectrometer Leak Detector
HV	High Vacuum
IITB	Indian Institute of Technology Bombay
MSLD	Mass Spectrometer Leak Detector
MOC	Material of Construction
NABL	National Accreditation Board for Testing and Calibration Laboratories
NDT	Non-Destructive Testing
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
P&ID	Piping and Instrumentation Diagram
PBG	Performance Bank Guarantee
PLC	Programmable Logic Controller
PT-100	Platinum Resistance Temperature Detector, 100 Ω
QAP	Quality Assurance Plan
RFP	Request for Proposal
RGA	Residual Gas Analyzer
RTD	Resistance Temperature Detector
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SITARE	Space Instrumentation and Technology for Astrophysics REsearch Laboratory
SITC	Supply, Installation, Testing and Commissioning
SS	Stainless Steel
T/C	Thermocouple
TMP	Turbo Molecular Pump
UPS	Uninterruptible Power Supply

Sr. No.	Item Description	Complied (Yes / No)	Additional Info if any
3. TECHNICAL SPECIFICATIONS			
3.1 General Performance Requirements			
1	Chamber Internal Size: 1000 mm Internal Diameter × 1000 mm Cylindrical Length (Approx.)		
2	Ultimate Vacuum Level: Better than 5×10^{-6} mbar (clean, cold, empty, dry, degassed condition)		
3	Temperature Range: -60°C to +150°C		
4	Temperature Uniformity – Steady State: ±2°C throughout the base plate working area at any stabilised set-point within the full operating temperature range		
5	Temperature Uniformity – Transient: ±15°C during active ramp phases; temperature to stabilise within ±2°C within a vendor-specified stabilisation time		
6	Temperature Control Accuracy: ±1°C at the selected control sensor		
7	Heating / Cooling Rate: Up to 1°C per minute across full temperature range, selectable; various ramp rates shall each be demonstrable independently		
8	Maximum DUT Heat Dissipation: 100 Watts		
9	Thermal Shroud Size: 900 mm Inner Diameter × 900 mm Cylindrical Length (Approx.)		
10	Thermal Base Plate Size: 700 mm × 800 mm (minimum)		
11	Continuous Operational Duty Cycle: ≥400 hours of uninterrupted thermal-vacuum cycling operation without requiring intervention		
3.2 Vacuum Chamber Construction			
12	Configuration: Horizontal cylindrical single-wall construction		
13	Material of Construction (MOC): Stainless Steel 304L (ASTM A240 / IS 6911:1992 Grade 02Cr18Ni11 or equivalent); NABL-certified laboratory shall be provided		
14	Front Door: Hinged dished end door with electro-pneumatically operated clamps. The number of clamps shall be specified. It shall also be ensured that no manual intervention is required for locking and that the desired vacuum level is achieved after automatic pneumatic locking.		
15	Door Seal: Precision moulded Viton O-ring (not spliced); groove surface finish better than 1.6 µm Ra		
16	Rear End: Welded dished end		

Sr. No.	Item Description	Complied (Yes / No)	Additional Info if any
3. TECHNICAL SPECIFICATIONS			
17	Gaskets and Other Seals: Viton O-rings and gaskets throughout all other sealing interfaces		
18	Flange Standard – HV Interfaces: ConFlat (CF) flanges with OFHC copper gaskets for all high-vacuum feedthroughs. KF flanges for gauge port interfaces.		
19	Leak Rate – Per Weld Joint: Better than 1×10^{-9} mbar·L/s (demonstrated by Helium MSLD)		
20	Leak Rate – Overall System: Better than 5×10^{-8} mbar·L/s (demonstrated by Helium MSLD)		
21	Chamber Wall IR Emissivity: ≤ 0.15 on inner chamber wall surfaces (to minimise parasitic radiative load on the thermal shroud)		
22	Internal Surface Finish: Electropolished to $Ra \leq 0.4 \mu\text{m}$. Vendor shall state the method and resultant Ra value in the technical bid		
23	External Surface Finish: Powder-coated or painted to a neat industrial finish		
24	Design Code: ASME Section VIII, Division 1 or IS 2825:1969 (whichever is more stringent as interpreted by the vendor's design engineer); weld qualification per ASME Section IX or IS 7307/IS 7310 (Part 1) as applicable.		
25	Support Structure: Mild steel support structure, suitably finished, to hold the chamber horizontally; anchored to floor with adequate fasteners		
26	Internal Cleanliness: All internal surfaces of the chamber, shroud and base plate shall be thoroughly degreased and cleaned (solvent wipe and/or ultrasonic cleaning) before assembly. No hydrocarbon contamination from machining, forming or handling shall remain. The assembled chamber shall be suitable for testing contamination-sensitive satellite subsystems.		
27	Structural Analysis: Vendor shall submit FEA / stress analysis of the chamber shell, dished ends and main flanges for vacuum load and full thermal cycling range, as part of the DDR/CAD drawing submission.		
3.3 Ports and Feedthroughs			
	<i>Note: Final port positions shall be decided during the design review stage. The vendor shall submit a proposed port layout drawing for IIT Bombay approval prior to fabrication.</i>		
28	Flange Standard: All vacuum feedthrough ports shall use CF (ConFlat) flanges with OFHC copper gaskets KF flanges for gauge port interfaces.		

Sr. No.	Item Description	Complied (Yes / No)	Additional Info if any
3. TECHNICAL SPECIFICATIONS			
29	Electrical Feedthroughs: 50-pin D-sub (2 Nos.), 37-pin D-sub (1 No.), 25-pin D-sub (1 No.)		
30	Thermocouple Feedthrough: 50-pin D-sub T/C feedthrough (1 No.)		
31	RF Feedthrough: 18 GHz SMAF type (3 sets)		
32	Feedthrough Leak Rate: Maximum 1×10^{-9} mbar·L/s per feedthrough		
33	Vacuum Gauge Ports: Provision for Pirani gauge and Penning gauge; locations to be finalised at design review		
34	View Ports: With internal illumination lamps for visual inspection of DUT		
35	User Ports: Three user ports to be provided; locations to be finalised at design review		
36	Dummy / Blank Ports: Provided on all unused ports; additional blank CF flanges with copper gaskets supplied for future expansion		
37	RGA Port: One dedicated CF-flanged port (CF35 or CF40) shall be provided on the chamber body for connection of a Residual Gas Analyser (RGA). Location to be finalised at design review. The RGA instrument itself is not in the vendor's scope.		
38	Base Plate Utility Ports: Suitable ports/penetrations for thermal fluid feedthroughs, T/C leads and any other base plate services, with appropriate vacuum-compatible bellows or fittings		
3.4 Thermal System			
3.4.1 Thermal Shroud			
39	Material: Stainless Steel SS 304L sheet with integral cooling channels		
40	Configuration: Cylindrical shroud (900 mm ID × 900 mm length) plus flat shroud panels on front and rear doors, and extended shroud panels beneath the base plate for complete enclosure of the DUT working volume		
41	Inner Surface (DUT-facing side): Coated with high-emissivity black paint (e.g. Aeroglaze Z306 or equivalent); emissivity ≥ 0.85		
42	Outer Surface (chamber wall-facing side): Bright polished or coated to achieve emissivity ≤ 0.15		
43	Shroud Leak Rate: Better than 5×10^{-9} mbar·L/s (thermal shroud fluid circuit, tested with Helium MSLD)		

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3. TECHNICAL SPECIFICATIONS			
44	Front and Rear Shrouds: Front and back shrouds to have similar design and cooling system as the cylindrical shroud.		
45	Feedthroughs: Individual inlet and outlet fluid feedthroughs for shroud with vacuum-compatible connectors.		
46	Temperature Control: Independent temperature control for the shroud as compared to the thermal base plate.		
3.4.2 Thermal Base Plate			
47	Size: 700 mm (W) × 800 mm (L) minimum, mounted at bottom of working volume		
48	Material: Aluminium alloy 6061 with integral fluid circulation channels or serpentine grooves		
49	Temperature Range: –60°C to +150°C (at the plate surface, with 100 W DUT heat load)		
50	Flatness: Better than 0.5 mm across the mounting surface		
51	Top Surface Finish: Smooth finish for good thermal contact with DUT		
52	Temperature Sensors: Minimum 5 Nos. RTD (PT-100) or T-type thermocouples: 4 at corners, 1 at centre of the base plate		
53	DUT Heat Load Capacity: Up to 100 Watts		
54	Fluid Connections: Inlet/outlet with bellows for fluid circulation, routed through vacuum-compatible low-heat-loss feedthroughs		
55	DUT Mounting Provisions: Tapped M6 holes with helicoil inserts on a regular grid of 50 mm × 50 mm pitch (or finer) across the full working surface of the base plate, vacuum-compatible (no gas-trapping blind pockets). Final hole pattern and size to be agreed at design review and confirmed in CAD drawings prior to fabrication.		
56	Base Plate Movement: The base plate shall capable of moving in/out to facilitate DUT loading outside the chamber. Flexible fluid connections of adequate length shall be provided.		
57	Base Plate Height: The thermal base plate, in its loaded position, shall be at a height of approximately 800–1000 mm from finished floor level to facilitate ergonomic DUT loading and unloading. Vendor to confirm during site visit, and may slightly modify these numbers with IITB approval.		
3.4.3 Thermal Circulator			
58	Temperature Range: Capable of controlling base plate and shroud temperature from –60°C to +150°C. If the required fluid		

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3. TECHNICAL SPECIFICATIONS			
	set-point temperature is lower than -60°C in order to achieve -60°C at the base plate surface (accounting for thermal losses and fluid-to-plate delta-T), the circulator shall be designed or selected accordingly. The vendor shall demonstrate that the base plate is guaranteed to reach -60°C under maximum DUT heat load.		
59	Temperature Management: Appropriate circulator loop supplying the cylindrical shroud and the thermal base plate, to enable separate temperature control for both. Individual inlet and outlet feedthroughs for each.		
60	Temperature Control Integration: Circulator outlet temperature to be controlled via PLC/SCADA feedback from a user-selectable control thermocouple (see Section 3.6)		
61	Control Accuracy: $\pm 1^{\circ}\text{C}$ at the selected control sensor		
62	Thermal Fluid: The vendor shall specify the proposed thermal fluid (make, grade, and datasheet) in the technical bid. The fluid shall be suitable for continuous operation across the full temperature range of -60°C to $+150^{\circ}\text{C}$, compatible with aluminium alloy 6061 (base plate), SS 304L (shroud and pipework), and all elastomeric seals used in the system. The proposed fluid should be clearly stated in the presentation to IIT Bombay, and is subject to approval by IIT Bombay before procurement. As a commissioning spare, the vendor shall supply an additional amount the approved fluid sufficient for a complete replacement of the fluid being used in the system.		
3.5 Vacuum Pumping System			
	<i>Note: The vacuum pumping system shall comprise a combination of roughing pump(s), a roots blower (booster pump), and a turbo-molecular pump (TMP) of adequate capacity to meet the pump-down time and ultimate vacuum requirements. The vendor shall propose a complete pumping scheme and justify the selected configuration. The following are indicative minimum capacities based on system requirements:</i>		
63	Roughing Pump: Minimum $65\text{ m}^3/\text{hr}$ pumping speed; suitable for continuous roughing and as TMP backing pump; oil-free dry type preferred		
64	Roots Blower (Booster Pump): Minimum $500\text{ m}^3/\text{hr}$ pumping speed; to operate in conjunction with the roughing pump		
65	Turbo Molecular Pump (TMP): Minimum 2100 L/s pumping speed; with dedicated controller and vent valve		
66	High Vacuum Gate Valve: Electro-pneumatically operated gate valve isolating TMP from chamber; fitted with proximity/limit switches for position indication and safety interlock.		

Sr. No.	Item Description	Complied (Yes / No)	Additional Info if any
3. TECHNICAL SPECIFICATIONS			
67	Roughing Valve: Electro-pneumatically operated right-angle valve in the roughing line		
68	Backing Valve: Electro-pneumatically operated right-angle valve in the TMP backing line		
69	Vent Valve: Electro-pneumatically operated right-angle valve to admit dry air or nitrogen through a 5-micron filter for chamber venting.		
70	Vacuum Pipelines: Stainless steel vacuum plumbing with flexible bellows adaptors at pump connections.		
71	Pirani Gauge: 2 Nos., measuring range 1000 to 10^{-3} mbar		
72	Penning (Cold Cathode) Gauge: 1 No., measuring range 10^{-2} to 10^{-7} mbar		
73	Dial Gauge: 1 No. on chamber for rough vacuum indication		
74	Ultimate Vacuum: $\leq 5 \times 10^{-6}$ mbar (clean, cold, empty, degassed chamber)		
3.5.1 Pump-Down Time Requirements			
	<i>Note: Pump-down times shall be demonstrated during FAT and SAT with the chamber in a clean, cold, empty, dry, degassed condition. The vendor shall demonstrate these times as independent acceptance criteria.</i>		
75	Rough Pumping (atmosphere to 10^{-2} mbar): ≤ 35 minutes from atmospheric pressure (1013 mbar)		
76	High Vacuum (10^{-2} mbar to $< 5 \times 10^{-6}$ mbar): ≤ 70 minutes after rough vacuum hand-off to TMP		
3.5.2 Compressed Air Supply (Vendor Scope)			
	<i>Note: Compressed air for electro-pneumatic valves is not available at SITARE Lab, IIT Bombay. The vendor shall supply a complete compressed air system as part of the scope of supply, comprising:</i>		
77	Oil-free rotary screw air compressor of adequate capacity for all electro-pneumatic valves and interlocks		
78	Air receiver / reservoir tank of adequate volume		
79	Refrigerated air dryer to supply dry, instrument-quality compressed air		
80	Filter-Regulator (FR) unit at point of use for each pneumatic valve train		
81	All interconnecting air lines and fittings		
	<i>Note: The vendor shall confirm compressed air capacity and pressure requirements in the technical bid. IIT Bombay shall provide only electrical power (415 V AC, 3-phase, 50 Hz) for the compressor.</i>		

Sr. No.	Item Description	Complied (Yes / No)	Additional Info if any
3. TECHNICAL SPECIFICATIONS			
3.6 Control, Instrumentation and Software			
3.6.1 PLC and SCADA			
82	PLC: Industrial-grade Programmable Logic Controller with sufficient I/O for complete automation of vacuum and thermal cycles; with emergency-off switches and full safety interlock logic.		
83	Operating Modes: Three fully implemented operating modes: (1) Automatic – pre-programmed cycle runs unsupervised; (2) Semi-automatic – step-by-step operator-confirmed sequence; (3) Manual – individual valve/pump control by operator. Mode switching shall be via SCADA interface.		
84	Test Profile Storage: Ability to store and recall a minimum of 20 (twenty) independent programmable test profiles. Each profile shall define the complete thermal-vacuum cycle (vacuum set points, temperature ramps, soak times, ramp rates, etc.).		
85	SCADA Software: PC-based supervisory control and data acquisition with user-friendly GUI for real-time monitoring, data and metadata logging and report generation.		
86	PC Specification: Minimum: Intel Core i5 (12th generation or later), 8 GB RAM, 1 TB SSD, 26" LED display, licensed Windows OS. UPS-backed. Other configurations may be proposed to and approved by IIT Bombay.		
87	Software Licence: All SCADA, control and data acquisition software licences shall be registered in the name of IIT Bombay. A backup copy of all software (installer media, licence keys) shall be supplied on a dedicated USB drive and stored separately from the SCADA workstation.		
88	Mimic Diagrams: Real-time animated mimic diagram(s) of the system P&ID on the SCADA screen, showing live valve states, pump status, vacuum levels and temperatures.		
89	Data Acquisition System (DAS): Up to 50 channels for job and system thermocouples; real-time graphical display with historical trending; data stored to hard disk periodically; failsafe mechanism to prevent data loss during power failure.		
90	Temperature Profile Display: Dedicated real-time display of the ongoing temperature profile (set point vs. actual) on the SCADA screen throughout any active test.		
91	Report Generation: Automatic generation of test reports; reports shall be exportable in Microsoft Word (.docx) and Microsoft Excel (.xlsx) formats.		

Sr. No.	Item Description	Complied (Yes / No)	Additional Info if any
3. TECHNICAL SPECIFICATIONS			
92	UPS Backup: Minimum 60 minutes uninterrupted power supply for SCADA PC and TMP controller.		
93	Dual-Monitor / Extended Display (Preferred): It is preferred that the SCADA system supports dual-monitor operation, with a dedicated monitoring window (real-time sensor display) separate from the main control window.		
94	User Authorisation Levels: The SCADA software shall implement at minimum two user authorisation levels — Operator (routine operation, data access) and Administrator (configuration, interlock setpoints, profile editing) — with password protection.		
95	PLC Spare Capacity: The PLC shall have a minimum 20% spare I/O capacity of each type (digital input, digital output, analogue input, analogue output), pre-wired to terminal blocks in the panel and available for future use.		
96	Email / SMS Notifications (Preferred): Preferred: SCADA shall support email or SMS notification to at least one nominated contact on occurrence of critical alarms (power failure, vacuum fall, over-temperature).		
3.6.2 Temperature Control			
97	Control Loop: PLC/SCADA shall control circulator outlet temperature based on feedback from user-selected base-plate thermocouple		
98	Selectable Control Sensor (Required): The operator shall be able to select, via the SCADA interface, any one of the base-plate thermocouples OR any DUT thermocouple (from DAS channels) as the active control sensor. This is a mandatory requirement.		
99	Control Accuracy: $\pm 1^{\circ}\text{C}$ at the selected control sensor during steady-state operation		
100	Ramp Rate Control: Operator-selectable ramp rates up to $1^{\circ}\text{C}/\text{min}$ shall each be individually demonstrable across the full temperature range.		
3.6.3 Cable Identification and Documentation			
	<i>Note: Cable tagging and documentation shall conform to the vendor's standard practice and shall be submitted as part of the documentation deliverables (Section 5.5).</i>		
101	All electrical and signal cables in the system shall be tagged with unique identifiers. The vendor shall provide unique alphanumeric cable tags on both ends of every cable, consistent with the wiring documentation		

Sr. No.	Item Description	Complied (Yes / No)	Additional Info if any
3. TECHNICAL SPECIFICATIONS			
102	Complete wiring diagram set (as-built) with every cable listed by tag number, source terminal, destination terminal, cable type and routing path		
103	Terminal block schedule and I/O list for the PLC		
3.7 Safety Interlocks and Alarms			
	<i>Note: The following safety interlocks shall be implemented and demonstrated as part of acceptance:</i>		
104	High Vacuum Gate Valve interlock: valve shall not open unless roughing vacuum reaches a preset threshold; proximity switches confirm physical valve position independent of electrical signal.		
105	Power failure protection: all vacuum valves shall close and all pumps shall de-energise on loss of power. Auto-restart facility shall be provided upon power restoration.		
106	Emergency stop: push-button switches shall allow the operator to de-energise all pumps and close all valves at any time.		
107	Pneumatic pressure monitoring: pressure switch shall alarm if the compressed air supply falls below the minimum operating pressure for electro-pneumatic valves.		
108	Pump thermal overload: motor overload protection for roughing and roots pump motors.		
109	Thermal interlock: over-temperature protection for the circulator and connected fluid system.		
110	Two independent programmable pressure interlocks configurable by operator to halt the thermal cycle or trigger an alarm at user-defined vacuum thresholds.		
111	The vendor shall ensure a dedicated earth for the control and instrumentation system with earth resistance $\leq 1 \Omega$. Chamber structure earth resistance shall be $\leq 2 \Omega$. Earth continuity shall be verified and documented at SAT.		

4. EVALUATIONS AND VENDOR REQUIREMENTS

4.1 Pre-approvals

112	Bidder/OEM should be able to demonstrate, submit FEA stress analysis, DDR/CAD drawings which must get approved by competent authority of IIT Bombay before fabrications (wherever applicable). The vendor shall provide a written undertaking that the final delivered product will be fully compliant with these approved drawings and plans.		
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4. EVALUATIONS AND VENDOR REQUIREMENTS

4.1 Site Visit

113	A site visit to SITARE Lab by the vendor is MANDATORY prior to bid submission, to verify laboratory dimensions, utilities, access constraints and any civil interface requirements. The vendor shall confirm the site visit in writing as part of the technical bid. Travel and accommodation costs for the site visit shall be borne by the vendor.		
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4.2 Previous Installation Visit

114	The vendor shall arrange for the IIT Bombay team to visit at least one previous installation of a comparable thermal vacuum system at an existing ISRO, DRDO or government research institution customer site. Contact information of at least two (2) such previous clients shall be provided; IIT Bombay reserves the right to seek user feedback and conduct additional site visits. IIT Bombay shall bear travel expenses for the IIT Bombay team, vendor is responsible for contacts and facilitating access.		
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4.3 Technical Bid Contents

	<i>Note: The technical bid shall contain, as a minimum, the following:</i>		
115	Compliance matrix as described in Section 4.3		
116	Preliminary system design description, including justification of selected pumping scheme, circulator selection and thermal shroud design.		
117	Preliminary P&IDs and system layout drawing (General Arrangement drawing showing overall dimensions and major components).		
118	Proposed port layout drawing for review and comment		
119	Vendor profile: company credentials, list of ISRO/DRDO/government-institution installations with client references and contact details		
120	Proposed makes and model numbers for all major components (Section 7)		
121	Milestone-based project schedule (Gantt chart) covering design, fabrication, factory testing, dispatch, installation, commissioning and SAT		
122	FAT test plan outline		
123	Site visit confirmation and any observations / civil requirements identified		
124	Signed declaration that all eligibility criteria (as per the vendor eligibility criteria in the Notice Inviting Tender)		

4.4 Technical Evaluation Process

4. EVALUATIONS AND VENDOR REQUIREMENTS

125	The technical evaluation process listed in Section 1.3 will be followed for determining technical validity of the tender and selecting tenders for financial bid opening.		
4.5 Pre-Fabrication Approvals (MANDATORY)			
	<i>Note: The following approvals by IIT Bombay are MANDATORY before commencement of fabrication. No fabrication shall begin without written sign-off from the IIT Bombay Principal Investigator (PI):</i>		
126	CAD Drawings: Complete set of fabrication CAD drawings for the chamber, shroud, base plate and support structure; along with FEA / stress analysis of the chamber shell, dished ends and main flanges for vacuum load and full thermal cycling range shall be submitted to the PI for review and approval before any machining or welding.		
127	Vacuum system design calculations: vendor shall submit pump-down time calculations (with conductance and effective speed analysis) for IIT Bombay review alongside the CAD drawings.		
128	Quality Assurance Plan (QAP): A detailed QAP for the entire scope of work shall be submitted and approved before fabrication commences. The QAP shall cover material inspection, in-process inspection hold points, radiography weld qualification, surface treatment, vacuum testing and final acceptance criteria.		
129	The vendor shall allow a minimum of two (2) weeks for IIT Bombay review of CAD drawings and QAP. Approval shall be in writing (email or signed document). IIT Bombay reserves the right to request revisions.		

5. SCOPE OF WORK

5.1 Deliverables

	<i>Note: The complete scope of work comprises design, fabrication, supply, transport, installation, commissioning, testing and handover of:</i>		
130	Thermovac chamber, thermal shroud system, thermal base plate and all associated thermal hardware		
131	Vacuum pumping system: all pumps, valves, gauges, pipelines, bellows and associated instrumentation		
132	Thermal circulator unit (chiller/heater) with all fluid distribution hardware and feedthroughs		
133	Control and instrumentation panel: PLC, SCADA workstation, DAS and UPS		
134	Compressed air supply system (oil-free rotary screw compressor, air receiver, refrigerated dryer, FR units and all air lines) – fully within vendor's scope		

5. SCOPE OF WORK

135	All interconnecting cabling, piping, bellows, support structures and cable trays		
136	A commissioning spares kit comprising a minimum of two sets of all Viton O-rings and gaskets used in the system (door seal, port blanks, feedthrough flanges, and fluid circuit seals), a minimum of two OFHC copper gaskets for each CF flange size used, and one complete set of replacement filter elements for the compressed air FR units. All commissioning spares shall be clearly listed and handed over at SAT.		
137	Any civil works required for system foundations, floor anchoring and utility routing, as identified during the site visit		
138	All tools, fixtures and consumables required for installation and commissioning		
139	Freight, shipping and handling, and insurance to be covered by the vendor		

5.2 Timeline

140	The complete system shall be delivered, installed, commissioned and accepted within eight (8) months of the date of receipt of the Purchase Order from IIT Bombay. The vendor shall provide a detailed Gantt chart showing all project milestones in the technical bid, including (at minimum): design approval, QAP approval, CAD drawing approval, fabrication start, vacuum vessel completion, subsystem assembly, FAT, dispatch, site installation, commissioning and SAT.		
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5.3 Factory Acceptance Test (FAT)

	<i>Note: The vendor shall conduct a Factory Acceptance Test (FAT) at the vendor's premises prior to dispatch, in the presence of authorised IIT Bombay representatives. The vendor shall notify IIT Bombay at least two (2) weeks in advance of the FAT date. The following minimum tests shall be conducted at FAT:</i>		
141	Complete visual and dimensional inspection of the chamber, shroud, base plate and all ancillary equipment against approved drawings and specifications.		
142	Verification of material conformance certificates (NABL-certified laboratory) and third-party 100% radiography of all chamber weld joints, in addition to DPT.		
143	Helium MSLD leak test: individual weld joints $\leq 1 \times 10^{-9}$ mbar·L/s; thermal shroud fluid circuit $\leq 5 \times 10^{-9}$ mbar·L/s; overall system $\leq 5 \times 10^{-8}$ mbar·L/s		
144	Ultimate vacuum verification: achieve better than 5×10^{-6} mbar in a clean, degassed condition		
145	Pump-down time demonstration: rough stage ≤ 35 min; high-vacuum stage ≤ 70 min		

146	Thermal system demonstration: demonstrate full temperature range from -60°C to $+150^{\circ}\text{C}$ with the circulator; verify temperature uniformity within $\pm 2^{\circ}\text{C}$ on the base plate with and without a 100 W load; verify heating and cooling rates at various steps up to $1^{\circ}\text{C}/\text{min}$ across full temperature range. Vendor shall arrange a dummy load for this purpose.		
147	The system shall demonstrate continuous uninterrupted operation through a minimum 24-hour automated thermal-vacuum cycle (as per a mutually agreed test profile).		
148	Selectable control sensor demonstration: verify operator can select any base-plate or DUT thermocouple as the active control sensor.		
149	Automatic, semi-automatic and manual mode demonstration		
150	Compressed air system performance check: verify adequate supply pressure and flow for all pneumatic valves		
151	Safety interlock verification: test all interlocks listed in Section 3.7		
152	SCADA and DAS demonstration: verify all channels, real-time display, mimic diagrams, test profile storage/recall, data and metadata logging, report export; verify source code or escrow arrangements confirmed in writing		
153	Chamber pressure rise test: with the chamber pumped to ultimate vacuum, isolate all pumps. Record pressure as a function of time for 30 minutes. The maximum pressure rise rate shall be specified by the vendor and approved by IITB during design review. The test should validate the approved design specifications.		
154	Inspection of all feedthroughs, CF flange assemblies and electrical connections for completeness and workmanship		
155	A mutually agreed detailed FAT test plan shall be prepared and submitted to IIT Bombay at least four (4) weeks before the FAT date. A comprehensive FAT report, signed by both parties, shall be provided before dispatch		

5.4 Site Acceptance Test (SAT)

	<i>Note: After installation and commissioning at SITARE Lab, IIT Bombay, a Site Acceptance Test (SAT) shall be conducted in the presence of IIT Bombay personnel. The following minimum tests shall be conducted at SAT:</i>		
156	Complete visual and dimensional inspection at site		
157	Helium MSLD leak test (repeat of FAT criteria) to verify no leaks introduced during transport and installation		
158	Ultimate vacuum verification at site		
159	Pump-down time verification at site		

160	Full thermal system demonstration at site: temperature range, uniformity $\pm 2^{\circ}\text{C}$, and heating/cooling rates up to $1^{\circ}\text{C}/\text{min}$ (across full temperature range) – both with and without 100 W load. Vendor shall arrange a dummy load for this purpose.		
161	The system shall demonstrate continuous uninterrupted operation through a minimum 24-hour automated thermal-vacuum cycle (as per a mutually agreed test profile).		
162	Selectable control sensor verification at site		
163	All three operating mode (Auto/Semi-auto/Manual) demonstrations		
164	Safety interlock verification		
165	SCADA and DAS demonstration including data and metadata logging, report export and test profile recall		
166	Full integrated system operation in automatic mode for a complete representative cycle.		
167	Chamber pressure rise test: with the chamber pumped to ultimate vacuum, isolate all pumps. Record pressure as a function of time for 30 minutes. The maximum pressure rise rate shall be specified by the vendor and approved by IITB during design review. The test should validate the approved design specifications.		
168	The SAT report, signed by both parties, shall constitute the basis for final acceptance and commencement of the warranty period. Extended testing and usage by the IITB team will continue during the warranty period and the vendor shall be responsible for ensuring that the chamber meets all specs.		

5.5 Documentation Requirements

169	The vendor shall supply the following documentation as part of the deliverables. All documents shall be provided in two (2) hard copies and one (1) soft copy (electronic, on USB drive). All documents shall be in English.		
170	Complete set of as-built drawings (P&IDs, mechanical assembly, pneumatic and electrical schematics, wiring diagrams with cable tag schedule, software documentation).		
171	Design calculations for vacuum chamber (structural analysis, pump-down capacity, thermal analysis)		
172	Operation and Maintenance (O&M) Manual: comprehensive guide for routine operation, preventive maintenance and troubleshooting		
173	Safety Manual: including HAZOP analysis summary, safety procedures and emergency protocols		

174	Quality Assurance documentation: approved QAP, NABL-certified material conformance certificates, weld inspection records, NDT reports, third-party inspection certificates.		
175	Calibration certificates for all gauges, sensors and measuring instruments		
176	SCADA and DAS software documentation, re-installation media and licence keys (on a dedicated USB drive separate from the workstation)		
177	Source code and project files for all custom-written PLC programs (ladder logic, function blocks, structured text) and SCADA application configurations shall be provided on the documentation USB drive. Where proprietary commercial software platforms are used, the vendor shall provide the platform project file (e.g. WinCC project, Ignition project). In the event that the vendor declines to release PLC source code outright, an escrow arrangement shall be agreed before contract signing, under which the source code is deposited with IIT Bombay and released to IIT Bombay in the event that the vendor ceases business or withdraws support for the system.		
178	List of recommended spare parts for ten (10) years of operation, with item descriptions and vendor part numbers		
179	List of all imported items and their sources of supply		

5.6 Training

	<i>The vendor shall provide comprehensive training to IIT Bombay personnel (minimum 4 persons) covering:</i> <i>Note: Training shall be conducted at SITARE Lab immediately after SAT, for a minimum of two (2) working days. The vendor shall prepare and supply training material in hard and soft copy as part of the documentation deliverables.</i>		
180	System operation: startup, shutdown and routine operation procedures (all three modes)		
181	Preventive maintenance: scheduled maintenance tasks, consumable replacement (O-rings, pump oil, filters, compressor service), and health-check procedures.		
182	Safety: hazard identification, emergency procedures and safe handling of the system.		
183	SCADA and DAS: software operation, test profile programming, data management and report generation		

5.7 Utilities to be Provided by IIT Bombay

	<i>Note: All other utilities (compressed air, refrigeration, etc.) are within the vendor's scope as specified in Sections 3.5.2 and 5.1. IIT Bombay will NOT provide compressed air.</i>		
184	Electrical Power: 415 V AC, 3-Phase, 50 Hz. IIT Bombay will provide power at a single distribution point; further distribution within the system is the vendor's responsibility.		

185	Water Supply: Regular mains water supply will be provided at the laboratory.		
186	Compressed Air: IIT Bombay will not provide compressed air.		

6. REPAIRS, MAINTENANCE AND ANNUAL MAINTENANCE CONTRACT (AMC)

6.1 Warranty

187	The entire system (chamber, pumping, thermal, control and all associated equipment) shall be warranted for a period of twelve (12) months from the date of final acceptance (successful SAT) by IIT Bombay. The warranty shall cover all components, workmanship defects, site visit costs etc. at no additional cost to IIT Bombay.		
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6.2 Preventive Maintenance During Warranty

188	The vendor shall conduct a minimum of two (2) preventive maintenance visits during the warranty period, at intervals of approximately six (6) months. Each visit shall include inspection and servicing of all major components (pumps, valves, O-rings, gauges, chiller, compressor, electrical panel, sensors) and shall be documented in a signed service report.		
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6.3 Breakdown Response

189	In the event of any breakdown or malfunction during the warranty period the vendor shall depute a qualified engineer on-site to SITARE Lab within twenty-four (24) hours of complaint being lodged. The system shall be restored to working condition at the earliest.		
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6.4 Spare Parts Availability

190	The vendor shall guarantee the availability of spare parts and consumables for a minimum of ten (10) years from the date of final acceptance.		
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6.5 Annual Maintenance Contract (AMC)

191	The Vendor shall undertake to provide a Comprehensive AMC for a period of three (3) years, which shall be all-inclusive and cover parts, labour, consumables, and two scheduled visits after the warranty period. The Vendor shall specify the percentage of AMC cost annually in the technical bid. The annual cost of AMC shall not exceed seven percent (7%) of the system price.		
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7. APPROVED MAKE LIST

	<i>Note: The following list provides the approved makes for key components. Equivalent makes with comparable specifications are acceptable, subject to IIT Bombay approval. The vendor shall clearly specify the proposed make and model for each component in the technical bid.</i>		
192	Roughing (Rotary) Pump: Leybold, Edwards, Pfeiffer, Busch, or equivalent		
193	Roots Blower (Booster Pump): Leybold, Edwards, Pfeiffer, Busch, or equivalent		
194	Turbo Molecular Pump (TMP): Leybold, Edwards, Pfeiffer, Shimadzu, or equivalent		
195	TMP Controller: As recommended by TMP OEM		
196	High Vacuum Gate Valve: VAT, MKS, or equivalent		
197	Roughing / Backing / Vent Valves: VAT, MKS, or equivalent		
198	Pirani Vacuum Gauge: Inficon, Oerlikon Leybold, Pfeiffer, or equivalent		
199	Penning (Cold Cathode) Vacuum Gauge: Inficon, Oerlikon Leybold, Pfeiffer, or equivalent		
200	PLC: Mitsubishi, Siemens, Allen-Bradley (Rockwell), or equivalent		
201	Thermal Circulator: Huber, Julabo, Lauda, or equivalent		
202	RF Feedthroughs: Plug-In, SHV, MDC, or equivalent		
203	Electrical / T/C Feedthroughs: Ceramaseal, MDC, Kurt J. Lesker, or equivalent		
204	Desktop PC (SCADA Workstation): Dell, HP, Lenovo, or equivalent (reputed make)		
205	Air Compressor (oil-free rotary screw): Elgi, Atlas Copco, Kaeser, Ingersoll Rand, or equivalent		

8. DIMENSIONS, LAYOUT AND FOOTPRINT

8.1 Laboratory Entry Door

	<i>Note: The complete assembled system (or its largest single component, if assembled on-site) must be capable of entering the laboratory through this door, accounting for any dolly, gantry or support equipment required during transport. Components may be assembled into a larger unit inside the laboratory. The vendor shall confirm these dimensions during the mandatory site visit and provide a transport and assembly plan.</i>		
206	Door Width: approx. 1.8 m, to be verified by vendor		
207	Door Height: approx. 2.0 m, to be verified by vendor		

8.2 Maximum Allowed Footprint for Final Installation

8. DIMENSIONS, LAYOUT AND FOOTPRINT

	<i>Note: The vendor shall verify the exact available floor area and ceiling height during the mandatory site visit before finalising the system layout. A dimensioned layout drawing shall be submitted as part of the technical bid.</i>		
208	Height: approx. 3.0 m, to be verified by vendor		
209	Width: approx. 3.5 m, to be verified by vendor		
210	Depth: approx. 4.5 m, to be verified by vendor		

9. VENDOR RESPONSIBILITIES

	<i>Note: The following responsibilities lie entirely within the vendor's scope. IIT Bombay shall provide electrical power (415 V AC, 3-Phase, 50 Hz) and regular mains water supply as described in Section 5.7. All other utilities, including compressed air, are the vendor's responsibility.</i>		
211	Design, fabrication, supply, integration, transport to site, installation, commissioning, testing and handover of the complete Thermovac system as per this specification.		
212	Conduct a mandatory site visit before bid submission to verify laboratory dimensions, utilities and access constraints.		
213	Submit fabrication CAD drawings for review and written approval by the IIT Bombay PI before any machining or welding commences (Section 4.5).		
214	Submit a Quality Assurance Plan (QAP) for review and written approval by the IIT Bombay PI before fabrication commences (Section 4.5).		
215	Supply the complete compressed air system (compressor, dryer, FR, air lines) for electro-pneumatic valve operation, as the site does not provide a compressed air supply (Section 3.5.2).		
216	Organise and conduct FAT at the vendor's premises and SAT at SITARE Lab, IIT Bombay, as specified in Section 5.		
217	Arrange third-party inspection of raw materials (NABL-certified lab) and weld joints (NDT, DPT, radiography as applicable) at various fabrication stages; provide all inspection certificates.		
218	Provide all documentation specified in Section 5.5 in the specified number of copies		
219	Conduct training as specified in Section 5.6		
220	Provide warranty support (including preventive maintenance visits) for twelve (12) months from final acceptance		
221	Guarantee availability of spare parts for ten (10) years from final acceptance		
222	Obtain prior written approval from IIT Bombay before subcontracting any part of this work		

9. VENDOR RESPONSIBILITIES

223	Inform IIT Bombay in advance of floor loading capacity requirements and any special requirements for civil works or utility connections / routing		
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