TECHNICAL SPECIFICATIONS OF THE CONTRACT FOR THE DESIGN, MANUFACTURE AND ASSEMBLY OF A VACUUM CHAMBER (TVAC)

1. OBJECT OF THE CONTRACT

The purpose of this contract is the design, manufacture, and assembly of a thermal vacuum chamber (TVAC) to facilitate testing of nanosatellites, microsatellites, subsystems, instruments, and electric propulsion systems for satellite missions developed by the Catalan space ecosystem.

2.- TECHNICAL SCOPE OF THE TVAC

The contracted TVAC must meet the following requirements:

Code	Physical Requirements of the Thermal Vacuum Chamber (TVAC)
RF-1	The cold plate must withstand test objects weighing up to 100 kg.
RF-2	Allow test objects of 800 mm wide by 800 mm high and 1100 mm in length.
RF-3	Cold plate of minimum 800 mm wide by 1100 mm long.
RF-4	Continuous internal diameter of the chamber equal to or greater than 1300 mm along the entire length and equal to or greater than 1200 mm inside the shroud.
RF-5	Have a minimum internal length of 1500 mm.
RF-6	Include a heating and cooling system that ensures a temperature range of -80 °C to +100 °C.
RF-7	Provide a minimum thermal gradient of 1 °C/min for the increase and decrease of the test object's temperature between -60°C and 80°C.
RF-8	Ability to dissipate a continuous generation of 100 W per test object within the temperature range defined in RF-7.
RF-9	Achieve vacuum levels equal to or lower than 1e-6 mBar.
RF-10	Capability to provide a stable and continuous vacuum in the range of 10 to 150 mBar.
RF-11	Ability to pump from atmospheric pressure (~1 Bar) to 1e-6 mBar in less than 5 hours.
RF-12	In the case of electric propulsion tests, sustain pressures lower than 1e-4 mBar while the test article is operating emitting 0.1 mg/s or less of ionic liquids.

Code	Technological Requirements of the TVAC
RT-1	Include a thermally controlled cold plate and shroud system that surrounds the interior of the chamber to ensure thermal stability.
RT-2	Temperature control system of the shroud and cold plate controlled independently by separate circuits.
RT-3	The thermal shroud must cover the entire interior of the cylinder, including the lateral cylindrical walls, bottom, and door.
RT-4	Removable sliding cold plate, with a minimum slide of 600 mm.
RT-5	Have at least one opening that allows full access to the chamber for installing the test objects.
RT-6	Include equipment and software for the control of parameters and operation of the heating, cooling, and vacuum processes.
RT-7	Have the capability to control and operate the TVAC remotely.
RT-8	Include at least one roughing pump and two turbomolecular pumps.
RT-9	Include a cold trap to capture particles at low pressure based on a closed-cycle system.
RT-10	Include at least 8 openings with flanges for pass-through mounting, distributed along the chamber with higher density near the chamber door. Minimum 2 ISO F, 2 ISO K, 2 CF, 2 KF/QF of 40 mm and 60 mm. Type and final arrangement to be agreed during the TVAC design phase.
RT-11	Include fixtures to facilitate support of the test items on the cold plate with a pattern of threaded holes.
RT-12	Arrangement of concentric windows of at least 100 mm in diameter located on the sides of the cylinder along the horizontal midline of the chamber, equidistantly spaced with a minimum of 6 lateral windows with their respective protectors in the shroud.
RT-13	Include two windows on the central concentric axis: one at the door and one at the end of the chamber with their respective protectors in the shroud.
RT-14	Provide separate valves/actuators to control different pump systems.

RT-15	Contain the following ports: • At least 4 high-voltage through-hole channels rated for a minimum of 5 kV. • At least 100 subminiature type D pin through-holes. • At least 8 BNC and 8 SMA through-holes.
RT-16	Include a temperature-controlled quartz crystal microbalance (TQCM) to measure volatiles and monitor chamber contamination.
RT-17	Include a residual gas analyzer (RGA) to detect and measure particles in the chamber.
RT-18	Contain a suitable system for cable guidance within the chamber.
RT-19	The TVAC must operate without the need for external supply of cryogenics.
RT-20	Include a minimum of two extra ports for future cryogenic installations.
RT-21	Provide a smooth surface protective system to prevent contamination and erosion of the interior of the chamber and shroud during electric propulsion testing (e.g., removable cylindrical casing for the bottom of the chamber).
RT-22	Provide all necessary communication cables, ports, and sensors for monitoring and controlling pressure and temperature.
RT-23	Have a minimum of 5 thermal sensors to monitor the temperature at 5 different points of the test objects and their respective temperature reading and register system.
RT-24	Include 2 separate pass-throughs for 5 thermal sensor connections each, one of type k and the other of type t.

Code	Additional Requirements
RA-1	Be compatible with the addition of extra sections in the future to extend the chamber size.
RA-2	Be compatible with the replacement of damaged sections/parts of the chamber.
RA-3	All sections, parts, and individual blocks of the chamber, including support structures, must be able to pass through a door of 1600 mm wide and 2000 mm high.
RA-4	Ensure the proper functioning of the TVAC by conducting a Factory Acceptance Test (FAT) and a Site Acceptance Test (SAT).
RA-5	Include delivery to the location, transfer of the TVAC into the defined room, installation, initial setup, and basic training for a minimum of five people.
RA-6	Include documentation with plans, connection diagrams, operation manuals, and information for proper maintenance and operations.

RA-7	Be manufactured according to EU standards (e.g., ECSS) and meet the corresponding safety requirements.

The materials, machinery, and other components necessary for the design and manufacturing of the TVAC are included in this contract, specifically:

- Vacuum Chamber, including flanges, windows, and pass-throughs (minimum of 8).
- A removable and sliding cold plate, with fixtures.
- Internal thermal shroud including openings aligned with the windows and their respective protectors.
- Thermal control system to independently control the temperatures of the cold plate and the internal shroud.
- Roughing pump.
- 2 turbomolecular pumps.
- Door/opening for the vacuum chamber.
- Equipment and software for sensor readings and to control the pressure and temperature of the chamber.
- Cables, ports, and sensors necessary for monitoring and controlling the pressure and temperatures.
- 5 thermal sensors for the test object and its respective temperature reading and recording system.
- Cold trap.
- Valves/actuators to control different pump systems.
- Pass-throughs with high voltage, power, and data connections (as per RT-15).
- Temperature-controlled quartz crystal microbalance (TQCM).
- Residual gas analyzer (RGA).
- Smooth surface protective system to prevent contamination and erosion of the interior of the chamber and shroud.

3. CONTRACT EXECUTION AND MONITORING PHASES

The contract will be divided into 3 phases, as described in the following table:

Phases		Description
Phase I	Design of the TVAC	This activity includes the technical design of the vacuum chamber. The design will be carried out according to the technical requirements defined in the previous section, covering aspects such as dimensions, materials, control systems, and interfaces for testing components and space systems, considering all the requirements listed in the object of the contract. Phase I will conclude with a report on the proposed design of the

		TVAC, which will be validated by the IEEC.
Phase II	Supply of Components and Manufacture of the TVAC	This phase consists of the contractor's physical construction of the chamber in accordance with the design specifications. This includes the manufacture of the TVAC and the integration of all components that meet all the requirements listed in the object of the contract. Phase II will conclude with a report on the manufactured TVAC.
Phase III	Effective commissioning and training of personnel	In this phase, the contractor will perform the final assembly of the chamber at the operation site, ensuring all connections and operations are correct. Subsequently, the contractor will be responsible for training IEEC and IFAE personnel in the operation and maintenance of the TVAC, including safety procedures and typical troubleshooting, in accordance with all the requirements listed in the object of the contract. Phase III will conclude upon passing the Site Acceptance Test (SAT) and completing the associated tasks of Phase III, subject to approval by the IEEC contract manager.

4. TERM OF THE CONTRACT AND DELIVERY PERIOD

The maximum term of the contract will be until 30 April 2025, considering the following interim milestones:
Phase I. Design of the TVAC: 3 months from the signing of the contract.
Phase II. Supply of materials and manufacture of the TVAC: 6 months from validation of Phase 1.
Phase III. Integration, effective commissioning, and training of personnel: deadline no later than 30 April 2025.

According to the collaboration agreement between IEEC and the Institut de Física d'Altes Energies (Institute of High-Energy Physics) in the framework of the CERCA GINYS III Programme for the collaboration in the development of scientific infrastructures through the acquisition of equipment and infrastructures for cooperative use of the research centres of Catalonia of June 2024, **the TVAC must be delivered to the following address:**

Institut de Física d'Altes Energies (Institute of High-Energy Physics)
Edifici Cn
Campus Universitat Autònoma de Barcelona
08193 Cerdanyola del Vallès

Castelldefels, June 2024.

Josep Colomé Ferrer
Director of the Area for the Promotion of the Space Sector of Catalonia
IEEC