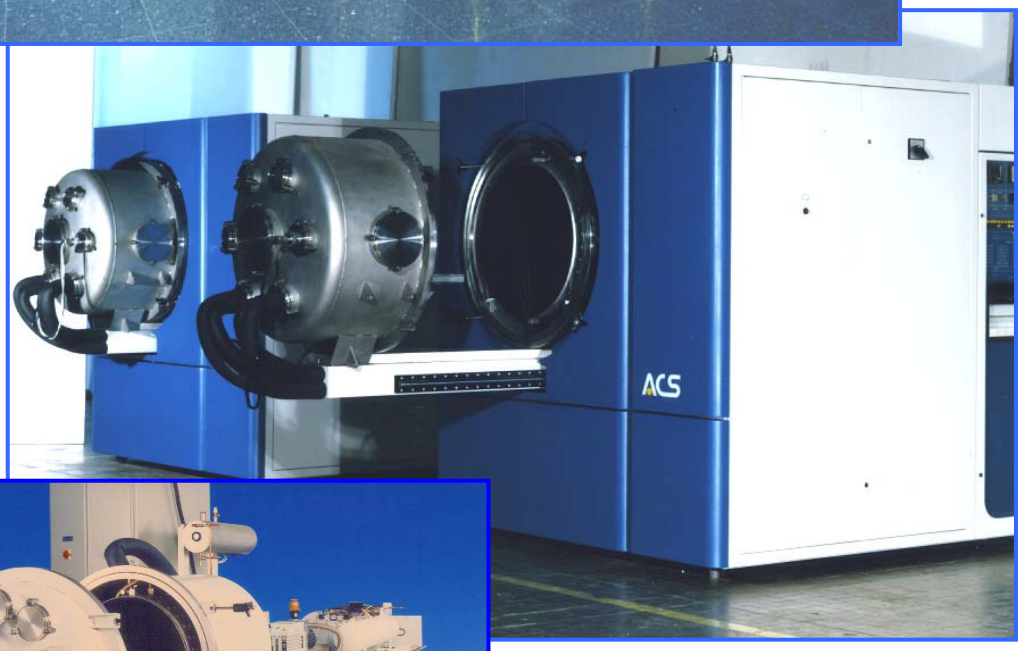
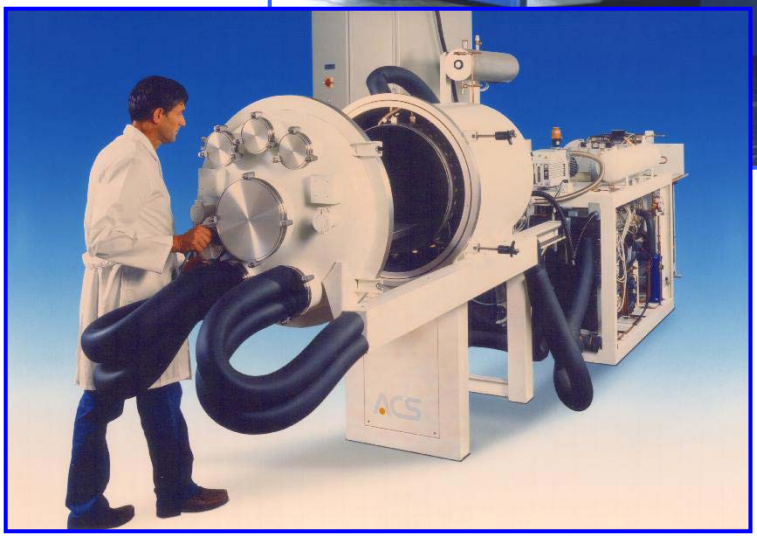
LTVC
Large Thermal Vacuum Chamber

OUR MAIN CUSTOMERS

Some Previous Projects





OVERVIEW

WHATEVER THE MISSION, be it manned or unmanned, for scientific research, applications or space transportation, a spacecraft and its payload must be able to withstand, first of all, the extreme stresses caused by the mechanical vibrations and the acoustic noise which occur during the launch phase, and, once in orbit, the rigours of the space environment. There is only one way of making sure of this: every single element of the vehicle and the instruments it is carrying must prove to be spaceworthy and must, therefore, be tested on Earth under conditions simulating those it will meet in space. ANGELANTONI's Test Equipment do just that.

Efficient test preparation, fast operations, reproducible test parameters and 'user-friendly' data presentations are the basic specifications for the Large Thermal Vacuum Chamber (LTVC); the design of the facility also take into consideration past experience and recent trends in test requirements.

The LTVC provides close simulation of in-orbit environmental conditions thus ensuring the optimisation of the design and verification of spacecraft and payload hard and software.

Thanks to the exceptional test volume available, it is an excellent tool for testing large payloads.

The specific design features and excellent performance characteristics of the facility mean that a number of tests can be carried out under high vacuum conditions, including:

Thermal tests:

- vacuum temperature cycling;
- solar simulation (available as option);
- infrared radiation (available as option).

Mechanical tests:

- deployment of large structures;
- dynamic balancing;
- photogrammetry for deformation measurements.

Subsystem monitoring and control are based on state-of-the-art technology and offer remarkable flexibility in selecting test mode combinations and sequences tailored to user requirements.

On-line computer-aided reporting on the performance of the facility itself provides a complete and detailed documentation of parameters and conditions during test activities, not only for the benefit of operations and maintenance but also in support of quick and efficient test analysis.

The LTVC proves itself to be a unique facility which sets new standards in space simulation techniques.

From the customer's point of view, it has two main advantages: it is, as already mentioned, a 'user-friendly' system which provides real-time information on the test subject. Secondly, thanks to the state-of-the-art technology used in designing the facility, it can be run very economically,
both from the point of view of operating costs and of consumables, and compares very favourably with smaller existing facilities.

THE CHAMBER

The LTVC chamber consists of:
– *the main chamber* is a horizontal cylinder with a door for access. The chamber contains a stable specimen support platform which, because it is insulated from both chamber and building
movements, has a low mechanical noise level a point of significant importance for dynamic tests, optical calibrations and heat-pipe operations during heat balance phases. Numerous flanges and ports for instrumentation, observation and, in particular, for photogrammetric equipment are also available thus ensuring that deformation tests can be carried out on specimens during vacuum and thermal testing;

THE SHROUDS

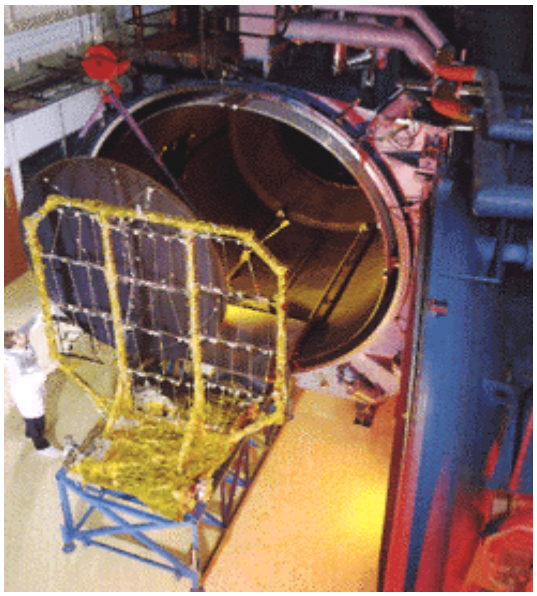
The chamber is equipped with a number of stainless steel shrouds that are temperature controlled, using liquid or gaseous nitrogen, in a range from 100 to 353 K depending on the operational mode chosen.
The shrouds can be independently controlled thus allowing various temperature combinations to be obtained.

THE HIGH VACUUM SUBSYSTEM

The LTVC is depressurised using a central pumping system and a dedicated high vacuum system. The minimum vacuum using LHe cryo-pumps. The chamber is
repressurised using GN_2 to 100 mbar and then clean air to reach atmospheric pressure. The total repressurisation time can be varied from 4 to 24 hours depending on needs.
Independent cryo-panels, put into operation early in the chamber evacuation phase and reconditioned only during repressurisation, provide optimum protection against contamination for both the test object and the facility optics.

DATA HANDLING

All control functions and readings (temperatures, process parameters, etc.) are collected from the various subsystems using programmable logic controllers. The data obtained are analysed and status outputs displayed on subsystem mimics and control indicators.
Data are also collected by a dedicated data handling computer for analysis and for detailed fault finding in case of failure.



MAIN FEATURES

General Requirements for design, manufacturing and installation of the thermo vacuum chamber are considered to completely carry out thermal vacuum tests for Subassemblies, Spatial Systems here below called *DUT (Device Under Test)*.

✔ **Useful Dimensions**

Diameter:	5.5	m
Length:	10	m

✔ **Shroud shape:** Horizontal Circular type.

✔ **Main Features:**

- Temperature range: 100K to 400K (on the shroud)
- Temperature heating up: 80K/h (on the shroud without load)
- Temperature cooling down: 60K/h (on the shroud without load)
- Temperature uniformity: 20K during the transition phases
- Temperature uniformity: 10K at steady conditions
- Ultimate pressure: 9 x 10^{-7} mbar at ambient temperature

Viewports Five (5) view ports for observing the specimen. Useful diameter of these view ports will be 250 mm minimum.

Ports **1)** Total of ten (10) DN 250 ports will be installed in the cylinder and positioned in the lateral wall.
2) Total of two (2) ports will be installed in the rear end position for future installation of thermal plate.

Materials

All part under vacuum:	Type 304 non magnetic stainless.
Rings:	Viton compound

Realization All the inner surfaces will be polished to minimise out gassing and radiation. All flanges, connections and fittings will be constructed of stainless steel. All sealing surfaces will be machined to eliminate leak risk. At least, 10 % of the vacuum weld length must be x-ray tested. If defects are detected, 100 % of the weld length should be x-ray tested.
Painting: All exterior surfaces will be properly finished with suitable epoxy paint.

Leakage
Overall leak rate < $2x10^{-5}$ mb / s^{-1}
Punctual leak rate < 10^{-8} mb / s^{-1}

Inner surfaces quality
Out gassing: after 3 hrs of pumping < 10^{-8} $mb / s^{-1} cm^2$
Contamination: after 72 hrs of pumping < $5x10^{-8}$ $g\ cm^2$
Emissivity: at ambient temperature < 0.2

Door The door will be opened sliding along to the vessel generatrix. The mechanism will be provided with safety brake. A proximity detector will stop the door near the chamber flange, then causes the closure of the pneumatic attachment jacks which will force the door into the chamber flange. When the safety brakes blocks the trolley, an indicator will be activated.

Decontamination Plate: The chamber will have a thermal plate to be flooded with LN2 located inside the chamber to condensate the out gassing that happens during the tests. The plate will work automatically.

Pump down with empty chamber and clean chamber: The pressure of 9 x 10^{-7} mbar will be reached in 24 hours at ambient temperature from the atmospheric pressure using only the rotative, roots and two cryogenic pumps

Rough pumping The pumps will be dynamically balanced and vibration isolated from other vibrations. The mechanical pump(s) will be equipped with adjustable gas ballast.
The roots type booster:

- It will operate from atmospheric pressure to an ultimate of 1x10^{-3} mbar.
- It will include an automatic overload protection.
- It will include at least a mechanical pump.

High vacuum pumping four cryogenic pumps will be provided. When regeneration of one pump is undertaken, the second pump can easily hold the chamber at the necessary vacuum level. Each pump will be isolated from the test chamber by a stainless steel high vacuum gate valve type electro pneumatically driven.
Two turbo-molecular pump units with its rough pump and isolation valve will be installed. It will also be isolated from the test chamber by a stainless steel high vacuum gate valve type electro pneumatically driven.

Repressurization system will comprise: After the test, the chamber will return to ambient pressure before opening, introducing GN2 by an automatic and regulated system. With the shroud at ambient temperature, the chamber will be brought from 9 x 10^{-7} mbar to ambient pressure in an adjustable time.
The repressurization system will include:

- A system to guarantee that the GN2 gets into the chamber at ambient temperature.
- One repressurization valve controlled from the control system
- A system guaranteeing that the atmosphere around the chamber door is safe.

Pressure measurements:
The pressure measurement will include:

- four Pirani type gage or similar.
- four Penning type gage or similar.

Thermal Shroud: Optically inert (covering the test volume) that makes the specimen to reach the required temperatures.

Leak Rate The overall leak rate for the shrouds, nitrogen supply, feedthroughs, supports and flanges inside the chamber will be less than 2x10^{-5} mb l s^{-1}
The punctual leak will not exceed 1x10^{-8} mb l s^{-1}

Thermo-optical requirement Surface emissivity on the shroud external side lower than 0.2 at any temperature
The internal surfaces of the shroud will be covered with special optical black paint in order to obtain a surface absorption rate for radiation higher than 0.9 at any temperature

Cleanliness requirements Degree of chemical cleanliness of surfaces < 5x10^{-8} g cm^2 after 72 Hrs of vacuum pumping at ambient T.

Temperature measurement control
No. 30 type T thermocouples (or Pt100 - to be decided at design time) placed on the shroud for its temperature control

The connectors and feedthroughs will be compact and sealed (maximum admissible leak rate per feedthrough: $1x10^{-8}$ mbar l s^{-1}). Type T thermocouples will be also installed on the inlet and outlet manifold of the shroud.

Thermal Shroud Design Criteria

As general criteria for achieving a better uniformity and thermal exchange, the shroud will be designed so the maximum possible surface is in contact with the cooling refrigerant. It will be manufactured in AISI 304 stainless steel.

The connections of the piping with external parts of the chamber will be effectuated with special bellows to obtain an easier disassembly. All points of contact between the shrouds and the chamber will be thermally isolated.

The shroud will be divided in at least four zones (front, rear, and two halves of the main body).

Thermoregulation System With GN2:

A thermoregulation system using gaseous nitrogen (GN2) will be installed. The system will allow the operation in the range 100K / 400K allowing stabilization at any temperature in between the extremes. All hard and soft interlock safety systems will be provided to prevent an uncontrollable situation, particularly at the interface between GN2 mode and vice versa.

Electrical Equipment

All the electrical equipment required for power cabling, power switches, electro valves will be centralized in a rack close to the chamber including a main switch for empowering the system in just one operation. The electrical cabling will be guided in a way that it doesn't interfere with maintenance works. Every input or output cable will be properly identified.

All the manufacturing and installation procedures will meet related European standards.

Thermocouples 400 "T" type thermocouples for temperature monitoring to be introduced inside the chamber through ports with connectors at both sides (indoor and outdoor) will be included in the supply. Each connector will cover a maximum of 15 thermocouples.

Control Equipment

The control system will contain:

- One PLC (Programmable Logic Controller) for real time control of the system
- One control console
- Software "WINKRATOS" for chamber remote control
- One synoptic software panel.
- Instrumentation for pressure, temperature, valves position, etc. located in a rack.
- One Data Acquisition System (DAS)

Control Console The console will be located within a radius of 20 m from the chamber and comprise the following equipment:

- Pentium PC
- Laser printer

Control Software The associated control software "WINKRATOS" will fulfil the following tasks:

- Diagrams will display functional status of all system components and safety interlocks
- It will also display the state of the main regulation loops
- Display, storage and print of all test facility functional data measurements
- Display, storage and print of all messages, alarm, etc.,
- Display test profiles with proper scaling as a function of time.

Data Acquisition System

The system will record data from thermocouples and the vacuum measurement system. DAS will have free channels to be used by the customer for electrical voltage recording up to a total of 500 channels.

System Configuration and Software
The configuration will perform an automatic data acquisition up to 500 channels. The system will include an data logging system as a safety device in the event of loosing test data. Data will be stored in hard disk.
The most important features of the DAS software will be as follow:

- English language
- Data acquisition up to 500 channels
- Data acquisition period programmable by S/W
- All functions can be selected by menu and icons
- Graphic representation in real time for graphics and numerical data of selected channels
- Data file generation and management
- Report generation

Dust Contamination — The thermal vacuum chamber will be designed to be used in clean rooms (FED STD 209E, class 100,000).

Chemical Cleanliness — The design and choice of materials will be done to eliminate any risk of contamination of the surfaces of the spacecraft under test by the condensable.
The contamination level of the test volume will remain below $2x10^{-7}$ g/cm^2

EMC
All the electric equipment of the thermal vacuum chamber will not affect from the electromagnetic point of view to its own functioning and to the acquisition and control system. All the electrical and electronic equipment installed in the chamber and its auxiliary subassemblies will show the CE mark according to EMC European Directives.

NOISE
The noise level will be lower than 80 dB(A) in the machine compartment and lower than 70 dB(A) in the testing area and control room.

Assembly
The electrical power (380V/50Hz/3 phases + N + G), treated water, electrical ground, evacuation ducts, GN2 & LN2 supply and compressed air, down to the chamber will be KARI's responsibility, also civil works and local conditioning. Any other supply or requirement for the installation will be supplier's responsibility.
Total power: 500kW approx.

Usual Partners/Subcontractors
ANGELANTONI INDUSTRIE S.p.A. use world-high-class quality parts and provide, during the project, the parts list of each batch. The parts list will include the name of manufacturer, model and detailed specifications of each part. Formal planning and inspection of manufacturing processes will be decided at the start of the project according to the Quality Procedures.

ISO 9001 NATO-AQAP110 ISO 14001