

A NEW LARGE VACUUM TEST FACILITY FOR HIGH POWER ELECTRIC PROPULSION TESTING

Fabrizio Scortecci

AEROSPAZIO Tecnologie s.r.l., I-53040 Rapolano Terme, Siena, Italy
Tel. +39 0577 724404, Fax. +39 0577 725254, Email: aerospaziotecnologie@tiscali.it

A 120 cu.m. Vacuum Test Facility has been developed at AEROSPAZIO Tecnologie with the aim of providing high qualified test services in Electric Propulsion and Space Simulation. The test facility consist of a stainless steel cylinder 3.8 m diameter and 11.5 m overall length. A modular cryopumping system rated for more than 200.000 l/s continuous pumping speed of Xe is presently under installation. Initial test services are planned for next summer.

Introduction

The implementation of any new technology in the satellite market requires a careful understanding not only on the performance but also on the integration issues. In this regard, Electric Propulsion, especially of high power, requires a particular extensive investigation due to the complex phenomena that occur on the fully deployed satellite. It is evident that the industrial development of high power electric thrusters rely on the availability of suitable test facilities where on-orbit operations can be simulated with reliability.

AEROSPAZIO Tecnologie, is a start-up company formed with the aim of providing high qualified test services in Electric Propulsion and Space Simulation to satellite industry and scientific institutions.

To run the business, a large Vacuum Test Facility specifically designed for high power EP testing on Xe propellant has been developed. The overall project has been fully set up on the basis of private capitals raised in the canonical way of the project financing in a scheme set available in our region thanks to a joint effort of local institutions and Banca Monte dei Paschi di Siena s.p.a. one of the largest Italian banking group.

During a hard work performed in less than two years, basing on the 1 million Euro raised capital, AEROSPAZIO purchased 7000 sq.m. estate, built 4500 cu.m. of laboratories and offices, and developed a 120 cu.m. Vacuum Test Facility fully serviced and instrumented.

Test Facility

The Vacuum Test Facility consists of a horizontal vacuum chamber 3.8 m diameter, 10 m cylindrical part length, 11.5 m overall length. The tank is equipped with two full diameter end caps that can be removed in order to allow the introduction of large test articles. Up to three sidewall service chambers can be connected with gate valves to large ports (900 mm diameter) of the main tank to allow testing several articles in parallel.

The vacuum chamber is mounted on a 45 tonn seismic block placed in the travertine crust of the local ground. A 5 tons gantry crane serves the test area. A 50 sq.m. platform placed in one side of the facility is used for test services.

The pumping system is arranged on four stages.

Roughing System

The forevacuum is performed with a two stage mechanical blower consisting of a booster roots pump backed by a rotary oil sealed vacuum pump. The pumping speed range to 1200 m³/h on Air.

Pumpdown System

A turbodrag system consisting of a 1000 l/s turbomolecular pump backed by a 30 m³/h dry pump allow to reach the level of 10⁻⁵ mbar without the use of cryos.

High Vacuum System

Consist of a cryogenic system rated for 20.000 l/s of air, allowing to reach an ultimate vacuum (static) in the range of 10⁻⁷ mbar.

Xe-Cryopumping System

It consist of a modular system of cryopanel maintained at the temperature of 40÷50K by means of high power cryorefrigerators mounted in small flanges of the chamber¹.

Each module can guarantee a pumping speed on Xenon of 15.000 l/s as a minimum. Many suitable flanges are available on the chamber. Therefore, the overall pumping speed capabilities of the facility will depend on the number of modules put in operation. The installation of modules allowing obtaining more than 200.000 l/s of continuous pumping on Xe for long duration test, is presently underway.

The vacuum diagnostics include thermocouple and hot-cathode ionization gauges, one quadrupole mass spectrometer. The DACS architecture is based on National InstrumentsTM PXI bus. Signals are multiplexed by a National InstrumentsTM SCXI system. Presently, up to 80 channels can be managed.

Test Arrangements

For high fidelity performance test (e.g. plume analysis) the thruster will be placed in the main chamber having a free firing length from 7 up to 9 meters, depending on the location of the thrust balance. Fast turnover test articles can be obtained by firing the thrusters in the transverse axis of the chamber, from the sidewall service chambers.

For long duration test, the facility is fully lined with graphite to minimise the backspattering effects of energetic ions.

References

¹ Garner, C.E., et al., "Methods for Cryopumping Xenon," 32nd AIAA/ASME/SAE/ASEE Joint Propulsion Conference, AIAA Paper 96-3206, Lake Buena Vista, FL, 1996.



Fig. 1. Access to test platform



Fig. 2. Service basement



Fig. 3. Vacuum chamber interior view

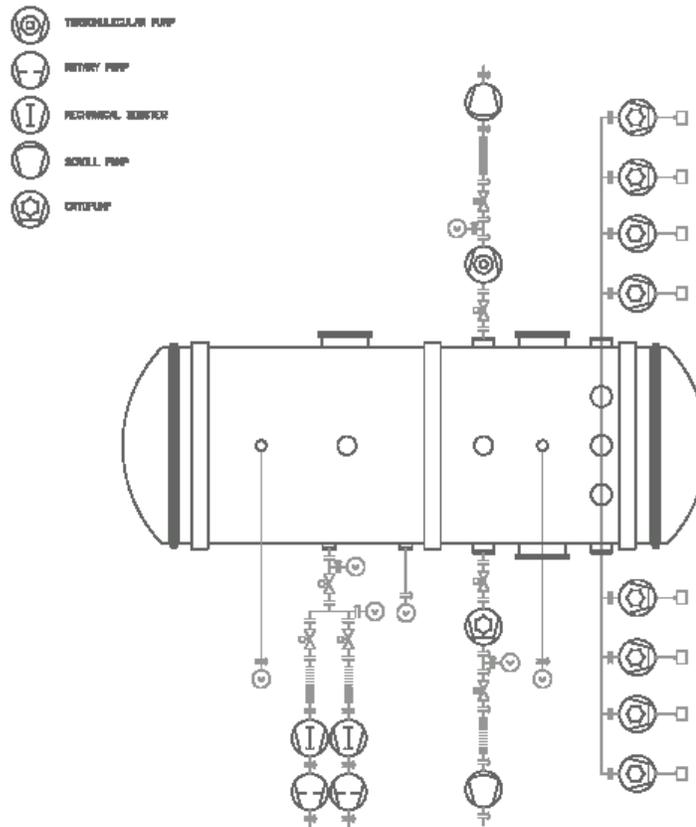


Fig. 4 Facility schematic