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GAS NEWS

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SPECIAL ISSUE

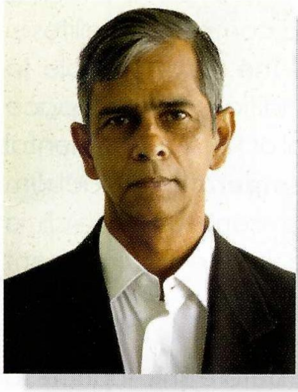
42ND SIG BAHRAIN

SEMINAR ON INDUSTRIAL / MEDICINAL GASES

DELEGATE MANUAL

CRYOGENICS IN ELECTRONICS

SHANKAR GHOSH -*SHELL-N-TUBE PVT. LTD.*



Shankar Ghosh,
Shell-N-Tube Pvt. Ltd.

Dr. Vikram Sarabhai – Founder

Prof. Satish Dhawan

India's space sector has made tremendous growth over the decade. Our advances in space programmes have been highly remarkable, with vigorous and determined efforts of ISRO.

Additionally, the space sector in India has been undergoing a considerable transformation with the de-regulation and opening-up of Space sector for the private sector.

Automated Thermal Vacuum Chamber for VSSC (ISRO)

ISRO ordered to AMOS a turn-key space simulator of 4.5m in diameter and 6.5m long. This system is a large vacuum chamber with thermal control, designed to test satellite components by reproducing the vacuum and thermal space conditions. Its imposing dimensions (close to 7m long and 5m diameter) reflects the image of India's ambitions in this sector. Completed after 4 years of research, this simulator has a pumping, cooling and controlled system and is installed in the Vikram Sarabhai Space Centre (VSSC) of the Indian Space Research Organisation (ISRO), at Trivandrum, in the south of India.The complete cryogenic system for this thermo vac chamber was designed and supplied and commissioned by us.

Thermal vacuum testing simulates a space environment, **by removing air and pressure and cycling very high and very low temperatures. Systems without solar simulator are known as Thermal Vacuum Chambers** . Thermovac system are **used in thermal control and offer a range of temperature from -190 C to +180 C**. These have shrouds for temperature homogenization inside the chamber. In addition, these systems can optionally use electrical resistors, gaseous/liquid nitrogen and thermal fluids.These systems also recreate the space environment conditions, including solar radiation, by using different devices in the test setup.

Photo - 1

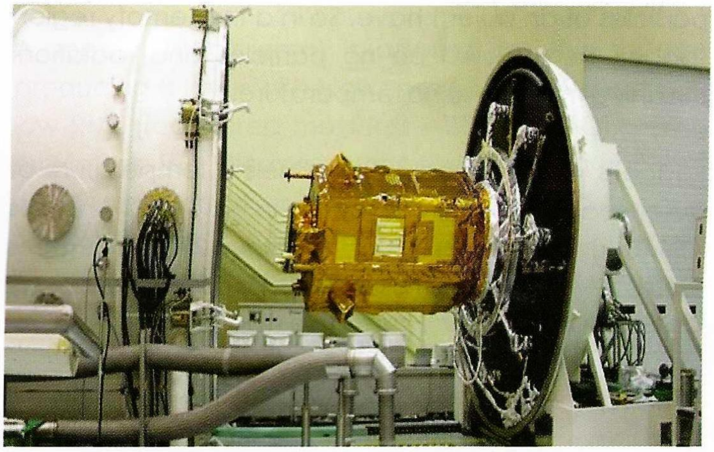


Photo - 2

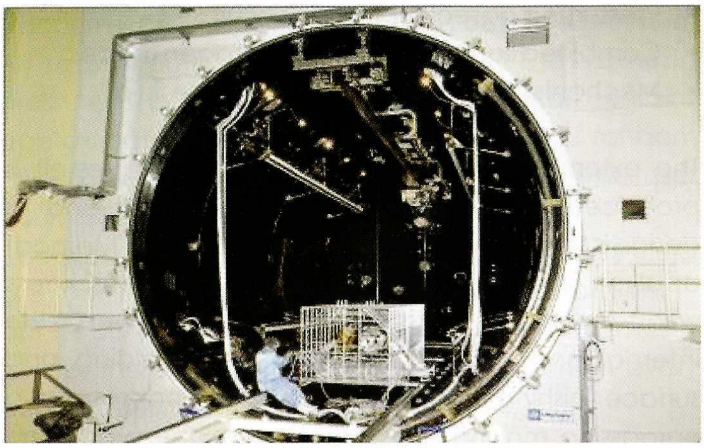
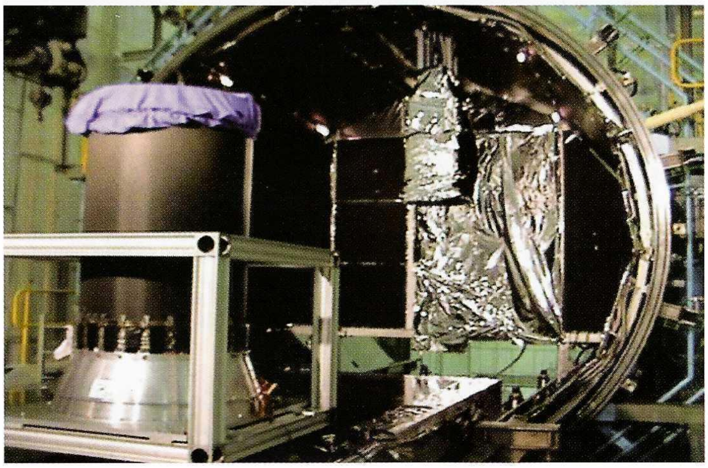


Photo - 5



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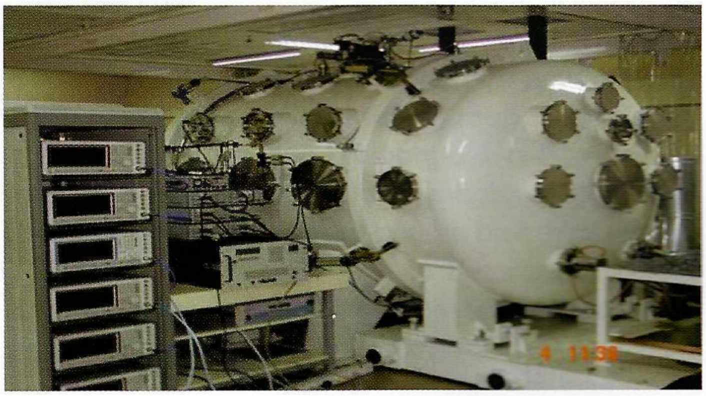

Photo - 7

Photo - 8

Photo - 9

Photo - 10

CHANDRAYAAN-1 underwent a series of tests for several weeks at the ISRO Satellite Centre (ISAC), Bangalore. It was broiled at temperatures of above 120 degrees Celsius, subjected to freezing conditions below minus 120 degrees Celsius and put in vacuum before it was declared flight-worthy and transported to Sriharikota.

During the thermo-vacuum trials, the spacecraft underwent soak and shock tests. It was subjected to high temperatures for a long duration in the soak test and went through high and low temperatures in quick succession in the shock test. Besides, Chandrayaan-1 faced a high level of noise and vibration tests to check whether its instruments held together. Elaborate tests were done on the solar panel to ensure that it unfolded like an accordion and that its antenna pointed in the right direction.

Of the 11 scientific instruments, five are from India. They were built for the first time in India, said T.K. Alex, Director, ISAC. After the spacecraft was fully integrated with its payloads, it was tested for almost three months for technical interfaces, communication between the instruments, and communication with the ground. For these and the thermo-vacuum tests, special facilities such as a space simulation chamber and an ultra clean room were set up at ISAC.

Photo - 11

Radarsat 2 before testing

Mars orbiter just before thermos vac testing

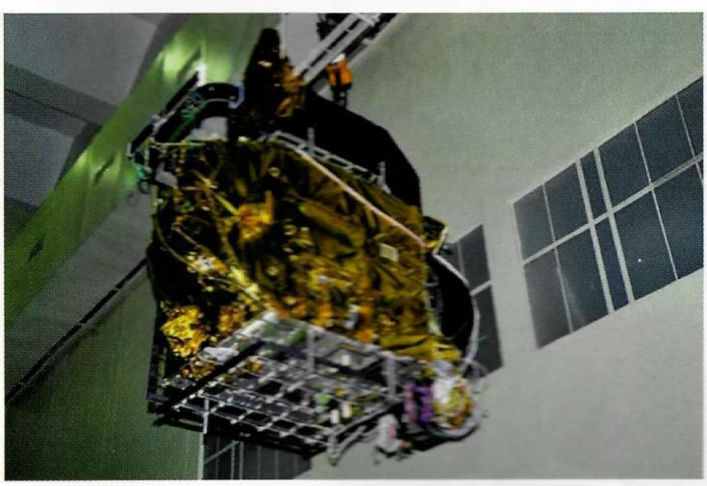

Photo - 12

Temp. range from - 70 ° C up to + 150 ° C Mechanical Cooling with Intermediate Fluid The fluid, typically a diathermic oil, cooled by refrigerant gas or heated electrically, is circulated by a magnetic coupling pump through the shroud in a closed loop. A benefit of this system is the low cost of ownership.

Temp. range from - 180 ° C up to + 150 ° C Pressurised Gaseous Nitrogen By means of a special fan, pressurised gaseous nitrogen circulates in the shroud maintaining a density that favours heat exchange and ensure a good temperature uniformity over the entire radiating surface. The heating takes place by means of electrical heaters, while the cooling by spraying of liquid nitrogen in the circuit. This system allows an excellent regulation of the temperature in the whole range.

Temp. range from - 196 ° C up to + 150 ° C Liquid Nitrogen + Irradiators In this case, the shroud is filled - wholly or partially - with liquid nitrogen, thus reaching a temperature -90k (between -196°C and -185°C depending on the pressure in the circuit). This creates a radiant cryogenic environment around the object to be tested. The circulation of the LN2 in the shroud may be of natural type or forced by means of a pump. The heating of the object under test or the control of intermediate temperatures, takes place by means of heating elements (infrared lamps or emitters) placed on special structures in the test volume.

The vacuum generation plant consists of a set of high quality and widely known brand of vacuum pumps. The first vacuum stage (primary or rough pumping) is performed by dry pumps, eliminating the risk of oil back streaming and characterized by very low maintenance. It allows the transition from ambient pressure to values of around 10-2 mbar in a short time. The second stage, consisting of more sophisticated pumps (cryogenic pumps), allows the achievement of a high vacuum with elevated reliability on the performances. Typical levels of final pressure inside the chamber are around 1x10-6 mbar, but it can drop to values in the range of 10-8 mbar depending on the time.

The control and management system of the TVC consists of a fully automated combination of hardware and software components. Sequencing, safety interlocks and operator interfaces are implemented through the PLC, the core of the control system. In case of failure of utilities like power, pneumatic supply, cooling water circulation, etc. The PLC provides built-in inter subsystem level interlocks to ensure the safety of operating personnel, test object and facility equipment. HMI devices are provided for local (on-board panel) and remote (PC dedicated software) control connected to the PLC.

Deep space missions including interplanetary exploration require electrical power management and control system that can operate efficiently and reliable in very low temperature environments. Spacecrafts operating in deep space carry a large number radio isotope heating elements the maintain the surrounding temperature of onboard electronic elements to around 20 C. Development of electronic systems capable of operating at cryogenic temperature would be capable of withstanding the hostile environment of deep space and reduce the system size and weight by reducing and maybe eliminating the need for radio isotope heating units and associated structures and systems.Net result of incorporating such electronic components would be to reduce launch as well as system development costs.

Radioisotope Thermoelectric Generators (RTGs) have been the main power source for US space work since 1961. The high decay heat of Plutonium-238 (0.56 W/g) enables its use as an electricity source in the RTGs of spacecraft, satellites and navigation beacons. Radioisotope heater units (RHU) are small devices that provide heat through radioactive decay. They are similar to tiny radioisotope thermoelectric generators (RTG) and normally provide about one watt of heat each, derived from the decay of a few grams of plutonium-238—although other radioactive isotopes could be used. Plutoninum-238 (Pu-238) is the ideal choice for most space missions because it produces a steady amount of heat and a half-life of 87 years. The half-life is important because a radioisotope must last long long enough to complete the mission.