

Environmental Testing

Thermal Vacuum Test: Thermal Balance

Purpose

This test will show the capability of the satellite to operate at the balanced temperature of the orbit cycle. The operation of the passive thermal control will be checked. The test will also assure that the radio equipment will function correctly in LEO.

Description

The full equipped and operational satellite will be tested. This test demonstrates the performance of the space-modified versions of the Hamtronics T-451 transmitter, the Hamtronics R-100 receiver and the Kantronics KPC-9612 TNC in a vacuum and over a wide temperature range, as will be encountered in LEO. The temperature will be monitored in all subsystems. Throughout the orbit the best case and the worst case temperature limits of the satellite will be used. The temperatures estimated were a minimum of -75°C and a maximum of 51°C . Typical test ranges are -44 to 60°C [2], but FASTRAC is a much smaller spacecraft than typical satellites. The batteries must be closely monitored as they are the limiting factor of the satellite, minimum temperature of 5°C and a maximum temperature of 40°C .

Procedure

The vacuum chamber must have nitrogen cooled walls, be able to reach 10^{-5} torr., and have heater and infrared lights. A functional test must be done before closure of pressure vessel. Temperature must be closely monitored throughout the satellite. Outgassing measuring devices will also be in the chamber to measure gasses escaping from the satellite. The pressure will be reduced in the chamber until a pressure of 10^{-5} torr is reached. If possible the rate of pressure change must follow the shuttle's pressure change, as seen in Figure 2. The test will start at ambient temperature, and orbital simulations will start with a pass in the eclipsed side. The simulated orbit will be in the sun an average of 63.8% of the orbit. The estimated orbit period is of 90 minutes. The temperature will be

lowered to -85°C for the initial part of the orbit, and will remain in the simulated shade for 32.5 minutes. The temperature will then be increased to 61°C in the sunny side of the orbit, for 57.5 minutes. All subsystems must be able to operate during the simulated orbits. The test will finish after a temperature balance has been obtained or 10 orbits completed.

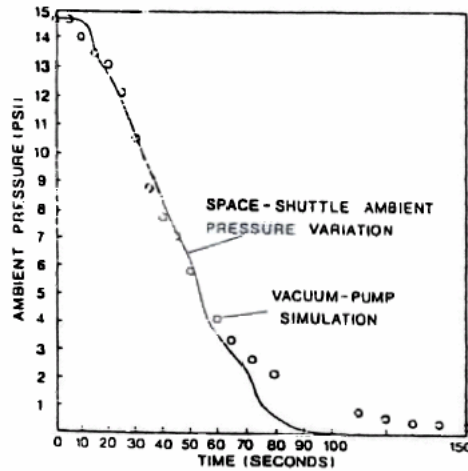


Figure 1. Simulated ambient-pressure variation during Space-Shuttle ascent [1].

Timeline

Start date: December 20th, 2004

End date: December 31st, 2004

Qualification Criterion

The temperature range must stay between the boundaries of the subsystems, especially the battery box, as it is the limiting subsystem. The communications equipment must meet mission link performance specifications without exhibiting excessive frequency drift.

Reference:

[1] A. Mironer, F. Reagan, "Venting of Space Shuttle Payloads", Systems Integration Engineering, Inc. Lexington, MA

Thermal Vacuum Test: Thermal Cycle

Purpose

The satellite must be able to meet and pass the design qualification requirements.

Description

The full equipped and operational satellite will be tested. This test demonstrates the performance of the space-modified versions of the Hamtronics T-451 transmitter, the Hamtronics R-100 receiver and the Kantronics KPC-9612 TNC in a vacuum and over a wide temperature range. The temperature will be monitored in all subsystems.

Throughout the orbit the best case and the worst case temperature limits of the satellite will be used. The temperatures estimated were a minimum of -75°C and a maximum of 51°C . Typical test ranges are -44 to 60°C , but FASTRAC is a much smaller spacecraft than typical satellites. The batteries must be closely monitored as they are the limiting factor of the satellite, minimum temperature of 5°C and a maximum temperature of 40°C .

Procedure

Similar to the thermal balance test, the satellite must be placed in a vacuum chamber, with pressures of 10^{-5} torr., and limit temperatures of -80°C and 61°C . The satellite must be fully functional before entering the vessel. After the pressure has dropped inside the chamber, the test will begin at room temperature and drop to the minimum temperature, where it will remain stabilized until the minimum temperature of a subsystem has been reached. The temperature will then be raised to the maximum allowable, and will remain stabilized until the maximum temperature of a subsystem has been reached. This cycle will be repeated at least 3 times.

Qualification Criterion

The satellite and its subsystems must demonstrate their described performance, and be able to sustain their specified temperature ranges.

Timeline

Start date: December 20th, 2004

End date: December 31st, 2004

Complete 72 hour test: Integrated Flight Stack Diagnostic

Purpose

This test focuses on the general functioning of the satellite. All modes of operation will be simulated. The power consumption of the integrated spacecraft and the ability of the power system to satisfy the system power requirements will be monitored.

Description

The integrated flight model including LightBand and solar cells, will be needed to complete the test. Flight model will be composed of tested, space-qualified components and the design will be based on improvements from the integrated prototype test. Test will be used to verify proper operation of the integrated flight hardware before release for NASA verification.

Timeline

Start date: December 20th, 2004

End date: December 31st, 2004

Qualification Criterion

The satellite must function properly. All subsystems must function as designed.