SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems Verification and In-Flight Experimentation (6)

Author: Mr. Carlos Pereira
beyondgravity, Switzerland, carlos.pereira@ruag.com

Mr. Sebastian Walz
RUAG Space AG, Switzerland, sebastian.walz@ruag.com
Mr. Giuseppe Rufolo
European Space Agency (ESA), France, giuseppe.rufolo@esa.int
Mr. Flavio Camarri
Thales Alenia Space Italia, Italy, Flavio.Camarri@thalesaleniaspace.com
Mr. Thierry Pichon
Herakles, Safran group, France, thierry.pichon@herakles.com
Mr. Renaud Barreteau
Snecma Propulsion Solide, France, renaud.barreteau@snecma.fr

IN FLIGHT EXPERIMENTATION FOR THE IXV RE-ENTRY VEHICLE - OBJECTIVES, EXPERIMENT DESIGN AND IMPLEMENTATION

Abstract

This paper describes the In-Flight Experiments system (IFE) foreseen for the IXV Re-entry Vehicle.

The re-entry vehicle is a 4.4 meter long slender body which is fully instrumented to capture details of its performance during the 30 minute hypersonic re-entry. Data are stored at a rate of 1-10 Hz until splashdown and transmitted to earth via telemetry. A transmission delay is implemented during the black-out phase.

The measurements characterize the overall heating behaviour and performance of the thermal protection system (TPS) while also capturing aero-thermodynamic phenomena such as shock-shock and shock-boundary layer interactions.

The objective of the sensor definition and placement in the vehicle is to maximize the amount of data while minimizing the number of sensors. To this end symmetric behaviour about the mid axis of the vehicle is assumed.

The nose of the vehicle uses a total of twenty thermocouples and nine pressure sensors to capture angle of attack and skin friction effects, stagnation pressure and thermal gradients of the C-SiC ceramic. Two displacement sensors and thirty two strain gauges record mechanical loads and measure the differential expansion between the nose cap and the vehicle carbon composite structure.

Similar measurement techniques are used for the windward ceramic tiles. A catalytic heating coating is implemented in the windward tiling.

The leeward, lateral and base of the IXV vehicle are covered by ablative material. Measurement of its behaviour requires a dedicated design of the thermocouple measuring system.

At the rear of the vehicle the flaps and hinge are instrumented using thermocouples and a comb system that allows unimpeded flap movement.

An infrared camera with periscope optics based on a sapphire mirror generates thermal maps of the flaps. The derived thermal maps are then used to determine the windward temperatures using inverse methods. The infrared optics integrates a rotating pass filter allowing independent measure of temperature and emissivity. This allows correction of angular position of the flaps as well as hydrazine and ablative

soot contamination. Images are compressed for transmission and stored in the data handling unit which analyzes them and sets gain and exposure of the camera.

The dimensioning driver in the design of the experiments is the high thermal flux sustained during the 30 minute re-entry.

The paper covers:

- Definition of the In-flight experiments and system architecture.
- Selection and testing of suitable sensors.
- Design of data acquisition system.
- Qualification and validation testing.