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

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THE USE OF INFRARED THERMOGRAPHY TO MEASURE IN-FLIGHT PERFORMANCE OF CONTROL SURFACES.

Abstract

This paper centers on the use of infrared thermography on the rear side of control surfaces (flaps and ailerons) to detect thermal effects on the windward surface and gauge movement during atmospheric re-entry.

The work is based on research performed on the european re-entry testbeds: EXPERT and IXV. The in-flight experiment consists of an uncooled camera taking images of the back side of a control surface in the near infrared at 25 Hz. The front sapphire optics can withstand very high temperatures without exposing the camera which is located inside the vehicle. A fiber optic bundle and relay lens system connect the camera to the optics. Images are stored in a data storage unit which also analyzes them and varies the settings of the camera. Gain and exposure speed adaptations allow measurement of the entire temperature range from 300C to 2000C with a 10 degree error.

In order to perform independent measurements of emissivity and temperature the system integrates a static pass filter in four different wavelengths thus transforming the camera into a multicolour pyrometer. This essentially allows temperature measurement regardless of contaminants or oxidation state of the measured surface and allows mapping of oxidation of the observed surface with time. The use of inverse methods allows calculation of the windward temperatures and thus observation of shock wave boundary layer interactions on the flap.

Analysis of the images, in particular projected surface and detectable movement of corners and edges, allows an accurate measurement of control surface movement during re-entry.

The system has been subject to extensive ground testing including powered acquisition during re-entry, EMC tests, sudden depressurization, high level pyroshock testing and thermal testing to 1000C on the front lens surface. The versatility of the system allows placement at a distance of 60 mm of the observed surface (wide angle optics) as proven in EXPERT or much larger distances using periscope optics (IXV).

Evaluation of the application of this technology towards its use to measure heat distribution in combustion chambers and nozzles during flight tests is on-going.