Small Probe Reentry Investigation for TPS Engineering (SPRITE) (IPPW-8)

Daniel M. Empey[1], Kristina A. Skokova[2], Parul Agrawal[2], Gregory T. Swanson[2], Dinesh K. Prabhu[2], Keith H. Peterson[2] and **Ethiraj Venkatapathy[3]**

1. Sierra Lobo, Inc., 2. ERC, Inc., 3. NASA Ames Research Center

e-mail:
Daniel.M.Empey@NASA.gov
Kristina.A.Skokova@NASA.gov
Ethiraj.Venkatapathy-1@NASA.gov

Abstract

At the 7th International Planetary Probe Workshop a paper [1] was presented proposing a unique strategy for Thermal Protection Systems (TPS) testing designed to strengthen the ground to flight traceability of TPS qualification programs. The concept presented was to develop an inexpensive small scale test platform, i.e., small probes that are fully instrumented, that can be tested both on the ground (in arc-jet facilities) and in flight. This proposed paper presents the results of a small focused project that addresses this concept, showing how such small probes were designed and then tested at full scale in an arc jet. This is a paradigm shift from the traditional stagnation point testing to one of "test what you fly", not only enabling traceability from ground to flight, but also enabling the assessment of practices/margins policies used in the design of the TPS of large scale entry vehicles such as Orion or MSL.

This effort, called SPRITE (**S**mall **P**robe **R**eentry **I**nvestigation for **T**PS **E**ngineering) has demonstrated the feasibility of ground testing flight-sized (35 cm diameter) reentry bodies with two very successful tests of full-sized instrumented proof-of-concept articles in the NASA Ames Research Center Aerodynamic Heating Facility (AHF). The objectives of this effort were to design, manufacture and test the article, develop a flight-like data acquisition system, demonstrate data gathering capability, application of design tools and assessment of their fidelity.

The SPRITE probe (a 90° included-angle sphere-cone, with a conical after-body) was designed to represent a vehicle that could be both an arc-jet test model as well as an actual reentry body. The probe was instrumented with TPS instrumentation plugs of the same design used on the MSL heat shield as well a number of back-face and internal thermocouples. Strain gages were also mounted on the TPS-protected aluminum structure in an attempt to determine thermo-structural response. Data from the sensors was collected by an internal data acquisition system as well as by the arc-jet facility. While it was not the intent of these tests to represent a specific mission, the models were tested at a heat flux (approximately 170 watts/cm^2) representative of a reentry through the Martian atmosphere.

This paper will present an overview of the SPRITE project including: overall design of the probe, thermal analysis of the probe, design of an internal Data Acquisition System (DAS), Computational Fluid Dynamic (CFD) simulation of the test conditions, thermal-structural analysis, and results of the arc-jet tests.

Acknowledgments: The present work was supported by the Entry Systems and Technology Division, NASA Ames Research Center and Contract No. NNA09DB39C to Jacobs Technology, Inc.

References:

[1] Howard, Austin R., Prabhu, Dinesh, K., Venkatapathy, Ethiraj, and Arnold, James, O.: "Small Probes as Flight Test Beds for Thermal Protection Materials" Proceedings of the 7th International Planetary Probe Workshop, Barcelona, Spain, 2010.