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IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Technologies for Future Space Transportation Systems (5)

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ADVANCEMENTS IN QUALIFYING THE REUSABLE THERMAL PROTECTION SYSTEM AND HOT STRUCTURES OF ESA SPACE RIDER

Abstract

The ESA Space Rider Program aims to enable routine European access to Low Earth Orbit (LEO) and return, facilitating a wide range of in-orbit experimentation capabilities while reducing mission costs through reusability. The Thermal Protection System and the Control Surfaces Hot Structure, managing the enormous heat generated during re-entry into the atmosphere and steering the vehicle against a challenging combination of dynamic pressure and high temperature, play a vital role. CIRA is tasked with designing, developing, and qualifying the entire Space Rider Ceramic Thermal Protection System, including the monolithic nose, the windward tiles, the landing gear door TPS, and the hinge TPS, along with the Body Flap Assembly Control surfaces. Drawing on lessons learned from the successful IXV re-entry demonstration, the Space Rider TPS and Hot Structure design focuses on reducing manufacturing complexity while enhancing integration ease, allowing for faster post-flight inspection and refurbishment. In partnership with PETROCEARMICS, CIRA has developed ISiComp®, a ceramic composite material based Liquid Silicon Infiltration of pyrolyzed phenolic-based carbon fiber pre-preg fabric. This process,

adapted from the high-end automotive sector for brake disc production, offers significant advantages in cost and production time over other ceramic matrix composites (e.g., CVI, PIP). Initially developed under the Italian National Aerospace Research Program, PRO.RA.-SHS, ISiComp® has demonstrated its effectiveness for manufacturing hot structures for re-entry applications through successful development tests of a full-scale prototype of the Space Rider Body Flap. Concurrently with design activities, a rapid testing program has been conducted to demonstrate both the manufacturing feasibility of large ceramic components and their ability to withstand the mission environment from launch to atmospheric re-entry, through LEO operations, ensuring full reusability up to six times. A comprehensive qualification plan is currently in progress. The paper presents the status of the project with a focus on qualification tests and manufacturing of the flight hardware.