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

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# SPACE RIDER THERMAL PROTECTION SYSTEM, AN ENABLING TECHNOLOGY FOR REUSABLE SPACE TRANSPORTATION SYSTEMS: DESIGN, DEVELOPMENT AND QUALIFICATION STATUS.

**Abstract**

Developing a reliable, fully reusable thermal protection system is a key element for effective and affordable Space Transportation solutions. CIRA, in partnership with PETROCEARMICS, has developed a ceramic composite material, named ISiComp®, based on Liquid Silicon Infiltration of pyrolized phenolic based carbon fiber pre-preg fabric. The applied process, inherited from high-end automotive sector for braking disc production, offers significant advantages in terms of costs and production time over other CMCs manufacturing techniques (e.g. CVI, PIP). ISiComp®, initially developed in the frame of the Italian National Aerospace Research Program, PRO.RA.-SHS, has demonstrated its effectiveness for the manufacturing of hot structures for re-entry application through a series of successful development tests of a full scale prototype of the Space Rider Body Flap. ESA Space Rider Program has the ambitious objective to enable European routinely access to LEO and return back to earth, allowing a wide spectrum of in-orbit experimentation capabilities while reducing mission costs through reusability. The Thermal Protection System and the Control Surfaces Hot Structure that allows respectively to manage the tremendous heat generated during re-entry into the atmosphere and to steer the vehicle counteracting a harsh combination of dynamic pressure and very high temperature play a fundamental role. CIRA has the responsibility for the design, development and qualification of the entire Space Rider Ceramic Thermal Protection System including the monolithic nose, the windward tiles, the landing gear door TPS and the hinge TPS in

addition to the Body Flap Assembly Control surfaces. Building on lessons learnt from the successful IXV re-entry demonstration, Space Rider TPS and Hot Structure design has been focused on reducing manufacturing complexity while improving easiness of integration that in turns allows for faster post flight inspection and refurbishment. In parallel with design activities a fast-paced testing program has been carried out to demonstrate on one side the manufacturing feasibility of the large ceramic components and on the other side the capability to withstand the mission environment from launch to atmospheric re-entry, passing through LEO operations, ensuring full reusability up to six times. A full qualification plan is currently being implemented. The paper presents the overall status of design, manufacturing and testing activities.