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

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SPACE RIDER: THERMAL PROTECTION SYSTEM AND HOT STRUCTURES DESIGN AND DEVELOPMENT STATUS.

Abstract

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. A key role for effective reusability implementation is played by 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. 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 Space Rider Body Flap. Following these positive results, in the frame of the phase D of the Space Rider program, CIRA has the responsibility for the design, development and qualification of the entire 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. The paper presents the status of both design and testing activities. 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 is being 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. Despite the very tight program schedule a full qualification plan will be implemented targeting the completion of the flight hardware manufacturing by the end of 2022.