SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Upper Stages, Space Transfer, Entry and Landing Systems (3)

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MISSION ANALYSIS AND GNC OF THE RE-ENTRY OF THE ARV CAPSULE

Abstract

This paper presents a summary of the Re-entry Mission Analysis and GNC activities covered by DEIMOS Space in Phase A of the Advanced Re-entry Vehicle (ARV) project leaded by Astrium ST under ESA contract. Two ARV system concepts have been considered, a Cargo and a Crew version. Results for both vehicles are here presented on both nominal and non-nominal re-entry missions from Low Earth Orbits (LEO), being the return from the ISS the typical mission scenario. Different areas of analysis have been covered and the results obtained in support to the prime on the consolidation of the mission scenario (from ISS parking orbit to parachute deployment) and the system performances are here presented. For what concerns the Flight Mechanics, the results of centre of gravity (CoG) Feasible Domains, Flying Qualities and Entry Corridors analyses are presented in support to the definition of critical vehicle and mission parameters like the CoG location, the Flight Path Angle at the EIP or the spin rate (in case of ballistic entry). For what concerns the Mission Analysis, efforts have been focused on the optimization of the separation sequence of the Re-entry module from the Service Module and the ISS Docking Adapter. The result is an innovative sequence of events with intermediate delta-Vs designed to optimize the separations of the three bodies avoiding risk of re-contact or debris falls on populated areas. An analysis of the debris, including also possible explosion of the service module, is presented to show the safety of the separation sequence. The aim of the tool used is not to produce a detailed analysis of the single debris but a quick and conservative assessment of the potential risks of the overall debris envelope. This is the right tool to provide efficient feedbacks allowing an optimum tuning of the best separations and delta-Vs sequence at mission design stage. The Guidance and Navigation for the entry phase have also been defined as well as the overall GNC architecture. An efficient guidance algorithm that tracks a reference acceleration profile, based on IXV heritage, has been designed and integrated as core function in the Functional Engineering Simulator (FES). End to end performances, obtained through extensive Monte Carlo campaigns from deorbiting to parachute deployment, show that the re-entry mission is safe and that, together with the system, has been correctly designed and tuned to successfully achieve the mission objectives respecting the constraints and requirements.