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

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IXV SEA-LANDING: DESIGN AND QUALIFICATION LOGIC

Abstract

The atmospheric re-entry is considered within the European Space Agency (ESA) as a major cornerstone, opening to a wide range of potential advanced applications ranging from the future launchers, to the planetary exploration, the crew and cargo transportation, the reusable space vehicles for on-orbit servicing, the sample return, and the space planes. In the past years significant importance was given to the development of re-entry technologies through several ESA basic research and technology preparatory programmes. Today, the inflight verification of such enabling technologies is considered an important programmatic objective to be pursued within ESA through the Intermediate eXperimental Vehicle (IXV) project.

One of the most significant tasks in the frame of the IXV project is to improve the competences for a sound design of the spacecraft structure taking into account a mission profile which includes, at the end of the re-entry phase, a parachute descent with a final landing in the ocean. During such sea-landing phase the high energy associated to the water impact event introduces a severe load environment for the TPS, the aero-shell and the equipment units. The objective of this paper is to present the overall IXV design and qualification logic against such a critical mission event. In order not to over-size the structure, it was required the vehicle to be recovered after the splashdown without significant damages, although localized plastic distortions are allowed. This approach can ultimately lead to relatively large non-linear deformations, with eventual contacts among the various components. The considered problem is too complex to be solved into an analytical form, while full scale experimental qualification campaigns are too expensive. Therefore numerical techniques, based on the use of 3D explicit non-linear dynamic finite element codes appeared to be the most practical and cost saving option. This simulation methodology was correlated, for different vehicle attitudes and landing conditions, to the experimental results of a drop test campaign carried out making use of a IXV scaled mock-up (1/4 of the IXV vehicle size). The overall water impact qualification approach will be complemented by the following activities: - Measurements of pressures and accelerations experienced at the splashdown of a full scale simplified mock-up. - Drop test of a dedicated representative structural assembly: Cold Structure Panel/ Thermal Insulation/ Equipped TPS Tile. The logic inter-correlation between the various experimental and numerical activities aimed to obtain a low-cost qualification and authorization to flight will be here presented and discussed.