Plasma Wind Tunnel Demisability Testing of Spacecraft Equipment

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Abstract

In previous activities on-ground testing in Plasma Wind Tunnels (PWT) that reproduce the plasma environment during re-entry have been used to characterize the behaviour of materials and simplified satellite structure samples at representative conditions. However, major uncertainties in the demise process are the fragmentation events occurring at both system and equipment level during the re-entry which can drive the casualty risk estimate. Parts that are predicted to produce a single ground-reaching fragment in today's state of the art simulations may actually generate several objects, having a severe impact in the overall casualty risk estimation.

With regard to these knowledge gaps, ESA Clean Space initiative has launched a new activity with Belstead Research Limited and the German Aerospace Centre (DLR) under the name of *Spacecraft Equipment Characterisation in Re-Entry Tests* (SECRET). The objective of this activity is to characterize the break-up processes of critical spacecraft elements through destructive on-ground re-entry tests to be performed in a Plasma Wind Tunnel. This work foresees significant improvement in the understanding of critical spacecraft elements and the on-ground re-entry experiments through testing and subsequent reconstruction in re-entry simulation tools. Development of representative models to capture missing, or poorly modelled, processes observed in the tests is planned.

In the frame of this activity, complex pieces of equipment are tested in the DLR L2K Plasma Wind Tunnel facility. These tests are essential to understand the break-up phenomena of that equipment, to improve the risk estimation and to implement effective D4D measures. The test results analysis provides a better understanding for the derivation of recommendations for Design for Demise. Further investigations are needed, taking also into account an improvement of the set-up of the experiments. Therefore, the post-test data analysis will provide a better understanding of the destructive processes of the selected hardware, for the benefits of prediction models and design for demise recommendations. The results will help to gain a deeper understanding of D4D for the benefit of early-phase space mission studies within space industries.

Keywords: Space Debris Mitigation, ESA CleanSat, Design for Demise, Plasma Wind Tunnel test