Containment Methods for the Atmospheric Reentry of Satellites

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Abstract

Internationally accepted guidelines and standards limit the casualty risk related to each atmospheric reentry to 1:10,000. To avoid having to perform a controlled reentry at End-of-Life (EoL), it is possible to design missions such that they are compliant to reenter uncontrolled. This is called the Design for Demise (D4D) approach. Most activities in the field of D4D aim at maximising the exposure of components to the flow, or minimising the energy needed to ablate components. This is typically done by replacing undemisable materials by more demisable ones, or by using early break-up technologies.

However, it may not always be possible or helpful to perform the aforementioned changes, especially for optical payloads which are at the core of their mission. Moreover, current formulas to estimate the casualty risk have the number of impacting fragments as the main driver, and largely neglect the kinetic energy at impact. Therefore, the ESA Clean Space initiative is studying novel methods to comply with guidelines, referred to as containment. This approach aims at keeping surviving fragments together, such that the probability of colliding with a person is reduced, often at the cost of having a higher impact energy.

Different containment methods have been preliminarily identified: boxes to fully enclose and shield critical parts, nets to fully enclose and partially shield critical parts, tethers to connect critical parts, and undemisable joints between parts connected by design. The feasibility, potential and challenges of these methods are to be assessed, despite early simulations suggesting positive results. Additionally, the suitability of risk estimation formulas has been considered, as simulation results suggest that containment may lead to extreme kinetic energies at impact that are currently not accounted for.

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