

SPACE DEBRIS SYMPOSIUM (A6)  
Mitigation and Standards (4)

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“DESIGN FOR DEMISE” TECHNIQUES TO REDUCE RE-ENTRY CASUALTY RISK

**Abstract**

The rising population of space debris is a growing concern. One mitigation approach is to remove debris from orbit by re-entering the Earth’s atmosphere either in a controlled or uncontrolled manner. To minimise the risk to human population, a requirement is imposed on spacecraft which will re-enter that the risk of casualties must be below  $10^{-4}$ . Compliance with this requirement can be easily achieved by performing a controlled de-orbit, but the impact in terms of mass and cost can be prohibitive. Hence the alternative is to ensure the passive and safe re-entry within 25 years.

“Design for Demise” is the solution proposed at system design level to ensure compliance to the risk requirement using uncontrolled entry. We will present the results of an ESA-funded project being run by Deimos Space, together with OHB System, EPFL and HTG, to identify, analyse and evaluate through detailed numerical simulations a set of techniques to reduce the re-entry casualty risk of any element of a satellite.

The approach taken consists of a several steps:

- to identify those elements of a satellite that are critical from a re-entry point of view using dedicated simulations
- to identify design-for-demise techniques applicable to those critical elements
- to validate the proposed techniques in representative mission scenarios making use of state-of-the-art simulation tools at different appropriate levels of fidelity
- to demonstrate the application of design for demise to a real ESA Earth Observation mission, CarbonSat, using a Concurrent Design Facility study to down-select the most promising set of

design changes which could be considered, followed by detailed specification of the changes and modelling to assess the benefit obtained and the system-level impact

- for the most promising techniques, to identify a dedicated technology roadmap to ensure a proper and timely development

We will introduce guidelines which can be used by systems engineers across the space industry throughout the satellite design process to understand the casualty risk from an uncontrolled entry, the design-for-demise techniques that could be appropriate depending on the mission, the benefits that could be achieved by incorporating these techniques in the design and the impacts they will have at systems level. We will also demonstrate tools which can be used for modelling at an appropriate level of fidelity.