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APPLICABILITY OF DRAG AUGMENTATION SYSTEMS TO ENABLE FUTURE LEO SPACECRAFT COMPLIANCE WITH DEBRIS MITIGATION GUIDELINES

Abstract

The adoption of the ISO24113 by ESA in 2014 has set an important milestone for the path towards an evolution and worldwide compliance of the Space Debris Mitigation (SDM) requirements. According to CNES approximately 60% of LEO objects are currently compliant with the 25 years residual lifetime guideline/requirement and there is a general trend to increase the efforts or at least “attempt” for post mission disposal.

However small classes of satellites show degraded adherence levels; this is also confirmed by the reliability analysis on the satellites’ subsystems performed by the authors in 2015. Considering that the future population in LEO will be dominated by space missions with mass below 1000 kg, the implications of non-compliances within these satellite classes should not be underestimated.

At Cranfield we propose to develop a range of drag augmentation systems to enable small satellite platforms to meet the SDM requirements. These devices represent an attractive solution both for spacecraft with propulsion capabilities, as a back-up strategy, and for the non-propelled as a primary disposal method.

This work investigates the additional drag area required for a sample of spacecraft to be launched in LEO, in order to review the applicability of a specific baseline design.

If the satellite’s lifetime is imposed at 25 years after the EoM, the ballistic coefficient required for the specific orbit altitude can be obtained. This is the upper limit to achieve a compliant re-entry time due to the action of natural perturbations. The calculation is performed with a simplified decay model for circular orbits, the atmospheric scale height and density values are functions of the constant solar flux. Two cases were considered: solar mean and solar minimum. The results are then compared for a test case both in STELA and DRAMA orbital decay simulation tools to evaluate the validity of the simplified model and the variations for different starting time during the solar cycle. The additional area is then evaluated for the sample of future non-compliant spacecraft derived from a previous study. In parallel the sail area achievable for the same spacecraft with a specific baseline design (Cranfield Icarus-1 type) is calculated and then compared.

The main outcome is to understand the scalability of the Icarus type of design and the modifications required to apply it to a wider range of satellite platforms. In addition this method can be a useful and easy tool to quickly verify the requirements compliance.