15th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Space Debris Removal Issues (5)

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# DEVELOPMENT OF A SOLID ROCKET MOTOR FOR AN ACTIVE DEORBITATION SYSTEM

## Abstract

This paper gives an overview of the design of an active deorbitation system based on a Solid Rocket Motor. Mission analysis and potential applications are presented. Work logic, main issues and possible solutions are shown. Moreover, conducted tests and development plans are given. The work presented is done within the European Space Agency's Clean Space initiative. The aim of this programme is to preserve Earth's atmosphere and enable slowing down the process of space debris generation. The main task of the work described is to develop an autonomous system based on solid rocket propulsion which allows the realisation of the Space Debris Mitigation 25-year rule. The study conducted focuses on satellites located in Low Earth Orbit within the mass range of 1000-4000 kg. A Vega class satellite (1500 kg) was taken as the baseline. The projected system is intended to provide a final burn in the two-step deorbitation manoeuvre. The first step would be performed by the satellite main propulsion system and would lower the orbit from an 800 km Sun Synchronous Orbit to 300 km. The second manoeuvre, completed using the proposed system, would lower the orbital perigee altitude from 300 to 40 km, thus allowing controlled re-entry. The paper shows the solid rocket motor design and system-level challenges. Detailed studies of the propellant, composition, storability, performance and grain geometry are described. Motor conditioning and ignition are discussed. Moreover, a higher-level system-spacecraft analysis was performed. A trade-off of possible Thrust Vector Control methods is provided. The paper highlights demanding issues that have to be solved during the development process. These are: no generation of particles over 1 mm in diameter (during motor firing), scalable design and a long burn time (around 100 s). The latter is caused by limited permissible acceleration of the satellite (up to 0.04g). A very low burn rate (2-3 mm/s) was found to be necessary. Moreover, competitiveness with liquid propulsion is analysed, especially considering possible propellant mass fractions for small systems. The mean thrust is about 400 N with the total impulse of 40 000 Ns and a propellant mass of 15 kg. The mass of the whole system is estimated to be 26 kg. The concept of clustering is also presented. A roadmap for system development is provided.