19th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Post Mission Disposal and Space Debris Removal 1 - SEM (5)

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PROPULSION FOR DIRECT DEORBITATION – SOLID ROCKET MOTOR WITH THRUST VECTOR CONTROL DEVELOPMENT

Abstract

This paper presents an overview of development of propulsion system consisting of Solid Rocket Motor and Thrust Vector Control designed at the Lukasiewicz Research Network – Institute of Aviation in Warsaw, Poland (L-IoA). After over 60-years of space age, there is an urgency to think about the protection of space environment: to prevent the continuous growth of debris population and to prevent orbits from becoming entirely inaccessible. One of the most important methods to mitigate the risk of the new space debris generation is its end-of-life utilisation. The presented project of the deorbitation SRM with the dedicated TVC system is one of the potential solutions. In order to provide high delta-V sufficient for direct deorbitation manoeuvres from LEO, a dedicated SRM can be proposed. The currently ongoing project of SRM is a continuation of a previous work made by L-IoA, which addressed a pre-qualification of a dedicated solid propellant compliant with solid particles generation restrictions. In current activity the main focus is put on the motor's Engineering Model design and testing. A unique approach to the uncommonly high burn time configuration was required due to acceleration limitations imposed by the potential fragile deployable appendages combined with high total impulse required. Scalability of the system implemented into this design in order to provide versatile solution for various missions and spacecraft's mass is also discussed. All aforementioned factors have a heavy influence on the design, therefore materials selection, raw materials cost and availability as well as manufacturing are taken into the consideration. Thrust Deflection System dedicated for this SRM aims at designing a mechanism to control thrust vector in order to assure a successful and safe re-entry to Earth's atmosphere. The design is

based on outside flaps which are deflectors located in the exhaust stream of a nozzle, at the exit plane. The kinematics of the concept is inspired by a mechanism commonly used in aviation, in a wing design. One of its great advantage is compactness: as flaps slide backwards before hinging inwards, they can be built around a nozzle in a way that they can be stowed and retracted within the SRM envelope. Compared to other methods, the design based on outside flaps is rather lightweight and it does not require changes into the SRM design. Proposed deorbiting propulsion system can become a crucial element in the end-of-life strategy for wide range of spacecrafts, helping safe utilisation of Earth's orbit.