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CHALLENGES OF DEVELOPING A SOLID ROCKET MOTOR FOR DIRECT DEORBITATION

Abstract

Using a Solid Rocket Motor for deorbitation manoeuvres can be advantageous. Although, requirements for such propulsion system are atypical in comparison to classic technology applications. This paper gives an overview of the preliminary design of such a motor, alongside with the development of dedicated propellant. Requirements consolidation is presented, giving a basic view of the main problem areas. The challenges are represented by a high total impulse required for direct deorbitation, combined with an acceleration limit for satellites with fragile appendages. Fundamental need of the unique solid propellant properties is addressed by elaboration of a new composition. The outlined propellant development description and basic test results are given, as an input for the motor design. The paper is focused on analysis and trade-offs performed as preparation for deorbitation Solid Rocket Motor development. Sizing is strongly connected with system level integration and possible system configurations are discussed. The impact of the thrust level limit due to acceleration, resulting in a long burn time requirement, is analysed and identified as a main design driver. Selection of the potential materials for ablative thermal insulation and nozzle throat is presented, alongside with its influence on the motor performance. The paper also shows results of initial ignition system tests in respect to the required reduction of solid particles and debris generation. Significant part of the work is devoted to high level system integration with a dedicated spacecraft, including Thrust Vector Control implementation and possibility of transformation into an autonomous system. The conclusions provide a roadmap for further development and testing. The work presented was performed by a fully polish consortium, led by the Center of Space Technologies at the Institute of Aviation in Warsaw, within European Space Agency's "Pre-Qualification of Aluminium Free Solid Propellant" project.