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SOLID PROPULSION FOR DIRECT DEORBITATION – MOTOR ENGINEERING MODEL DEVELOPMENT

Abstract

Direct deorbitation of a spacecraft requires high delta-V propulsion system. Thus use of a solid propulsion can be advantageous, limiting volume of additional propellant and assuring high reliability of end-of-life disposal. Such a dedicated Solid Rocket Motor is being developed by Lukasiewicz Research Network – Institute of Aviation and its partners in Poland, under successive projects realized for European Space Agency. This article provides an overview of the Engineering Model development status, planned to provide answers for the design challenges. This solution aims in basic configuration of 1 500 kg class satellites, although, via introduction of clustering and scalable design will be suitable for wider range of spacecrafts. This motor utilizes a novel propellant, developed by the consortium and recently pre-qualified for this application. Its main advantages are elimination of the solid particles in combustion products and relatively high performance at very low burn rates, both crucial features for considered application. Process of selection and trade-offs undertaken during the propellant development is also discussed in this article. The main emphasis is put on the design of the dedicated motor. Deorbitation propulsion application, compliant with the space debris mitigation guidelines, results in unconventional set of requirements as for a Solid Rocket Motor. High total impulse combined with accelerations limited by potentially fragile deployable appendages, sets the burn time on an exceptionally high level. This leads to thermal insulation and nozzle throat regression challenges. These issues are also addressed in this article, including results of preliminary test verification. Another design driver is long storage time, since the manoeuvre is planned at the end-of-life of the spacecraft. Storability, reliability and radiation impact were therefore also considered and their impact on the motor design is shown. All aforementioned

factors have a heavy influence on the materials selection, although, since economically attractive solution is desired, raw materials cost and availability as well as manufacturing is taken into the consideration. The motor integration with the spacecraft is also discussed and potential solution is outlined. System level considerations include also use of a dedicated Thrust Vector Control subsystem, which is planned to be developed in Lukasiewicz Research Network – Institute of Aviation.