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AERODYNAMIC IMPROVEMENT OF THE BRAZILIAN SATELLITE LAUNCH VEHICLE

Abstract

The first vehicle of Cruzeiro do Sul family, the VLS Alfa, will make use of the lower part of the first Brazilian satellite launch vehicle VLS, which is composed by solid propellant motors as first and second stages. However the configuration of VLS Alfa will make use of a liquid engine as third stage, in replacement of the third and fourth solid propellant stages of VLS. In a previous study the low part of VLS has been replaced by an only solid propellant motor with the same total propulsive energy amount. From the aerodynamic point of view, replacing the four solid boosters around the core and the second stage motor by a single solid rocket motor with a external diameter of 2.5 m, which will be followed by a second stage composed of a liquid propellant motor, a small apogee motor and finally the satellite fairing, all also with 2.5 m diameter, the configuration will be characterized by a slender geometry with the same diameter from bottom to top. Certainly this is the most efficient aerodynamic shape for a three stage launcher, and considerable gains will be achieved which were related to a clean shape with less aerodynamic losses. With this new configuration and in order to elaborate arguments for the shape and arrangement changes a review of all aerodynamic global characteristics have been made. The VLS Alfa should be designed to accomplish Brazilian space missions which concerns the transport of small satellites to equatorial as also to sun synchronous orbits from Alcantara Launch Space Centre in Brazil. In the previous configuration the vehicle was only able to transport small satellite to LEO. With the improved configuration and due to a strong reduction of the aerodynamic losses, VLS Alfa increases substantially its performance so that insertion of small satellites into high inclination polar or sun synchronous low earth orbits are now possible. The paper describes the proposed configuration, its actual performance and mission capability. Furthermore, a detailed discussion is presented, showing comparisons between aerodynamic global coefficients related to drag and static stability characteristics. Also discussions concerning optimisation of aerodynamic devices/segments of the proposed vehicle are presented. The study is concluded with presentation of aerodynamic gains using one or other configuration, as also their impact in trajectory, performance and finally the capabilities for accomplishment of space missions.