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RE-ENTRY ANALYSIS OF RESEARCH ROCKETS PAYLOADS

Abstract

The atmospheric re-entry of sounding rocket payloads is an important phase of the ballistic flight, especially when instruments and experiments shall be recovered for future flights or interpretation of experiment data. The understanding of the dynamic behaviour of cylindrical and cone-cylindrical payloads during the re-entry is a prerequisite to ensure a successful deployment of the parachute system. This includes not only the knowledge of the payload vehicle attitude and rate data but also the "global view" on deceleration, descent time and terminal recovery velocity. The paper describes the analysis work that has been conducted at the Mobile Rocket base of the German Aerospace Center (DLR) on flight data of several TEXUS and MAXUS payloads that have been reviewed and compared.Vehicles, where the centre of gravity coincides with the longitudinal aerodynamic centre, as it is the case for TEXUS, MAXUS and MASER payloads, are usually spun-up about the longitudinal axis before the entry in the atmosphere to eliminate concentration of surface aerodynamic heating and enhance the condition for flat spin. Analysis of flight data have shown that the payload spinning stops when dynamic pressure starts to build and it is stabilised to one lateral position depending on advices like Telecommando- or GPS-Antennae before the payload reaches the flight time with maximum deceleration. The differences in the flow separation, forces the cylindrical payload into a rotational motion about the axis of highest inertial moment when it reaches subsonic velocity. During the analysis work that has been conducted at the Mobile Rocket Base of the German Aerospace Center (DLR), flight data of several TEXUS and MAXUS payloads have been reviewed and compared. The availability of accurate GPS and sensor data supported to analyse the acceleration of the payload from 120 km on the descent. With the use of gravitation models the acceleration is reduced to it aerodynamic component only. The density of the atmosphere is taken from atmosphere models to calculate the drag coefficient which is dependent on payload attitude, Reynolds-Number and Mach-Number. Untill now estimations for drag coefficients were based on theoretical data and measurements of a cylinder in a flow field of a certain Reynolds-Number. Modelling the re-entry has been performed by simulating also the payload motion during its flight through the atmosphere, respectively the change of the drag. This paper describes the similar behaviour of the drag coefficient for sounding rocket payloads regarding the dependence on geometry, Reynolds-Number and Mach-Number.