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RESULTS OF THE FIRST STAGE DEVELOPMENT FOR THE ROMANIAN ORBITAL LAUNCHER NERVA

Abstract

The development of the NERVA small satellite launcher is under development for several years in Romania. The project has been recently sponsored by the research authority CNMP under the contract no. 82076, with the duration of three years. The target of the project is to achieve a launching capability for a payload of up to 4 kg, into a low Earth orbit of 100 miles, at 45 degrees with the equator. The first stage of the research is focused on the development of the booster stage of the space launcher during the year 2009. The development of this first, booster stage of the NERVA vehicle is presented, consisting of a cluster of three small size, identical solid rocket motors with an individual thrust of 600 kN at sea level. The program is targeted at achieving the launch capability with minimal modifications of the obsolete military source vehicle, of its launch platform and logistics. This target posed severe design problems regarding the reliability of the solid motor cluster and regarding the compulsory modifications of the launching platform, consistent with the given requirements. The design condition is focused on preserving the present technology of the solid rocket engine unchanged and to only modify the geometry of the exhaust nozzle in order to accommodate the clustering requirements. Although a major improvement would have been introduced by the redesign of the propellant grain geometry and its manufacturing technology, the first series of experimental developments is only focused on collecting statistical data on the present grain configuration, relevant for the thrust balancing of the triple-booster construction. Statistical tests are being performed with the cluster in a minimal configuration and flight engine performance data are collected during a series of experimental launches of the single stage version of the NERVA vehicle into the Romanian research facility during the spring of 2009. The level of the actual thrust into the real flight and the combustion instability due to propellant fragmentation are addressed during the real flight tests. The initiation phase of the ignition and the first transient combustion of the grain is investigated by means of numerical simulations in comparison to the experimental measurements on the pressure history in the combustion chamber. The start of combustion timing and scattering proves mainly produced by the random action of the pyrotechnical devices of the igniting system and far less by the gas-dynamic transient of the internal flow along the motor. The gas-dynamic time constant of the booster engine falls well within a 20 ms maximal duration. The conclusions of these tests for the further development of the three-staged rocket vehicle are debated.