SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS (D2)
Small Launchers: Concepts and Operations (7)

Author: Prof. Radu Rugescu
Politechnic University of Bucharest, Romania, rugescu@yahoo.com

Dr. Daniele Mortari
Texas A&M University, United States, mortari@tamu.edu
Mr. Ioan Farcasan
Electromecanica S. A. Ploiesti, Romania, elmec@elmec.ro
Mr. Mingireanu Florin
Romanian Space Agency (ROSA), Romania, florin.mingireanu82@gmail.com

STAGING MECHANISM STATUS OF THE ORBITAL LAUNCHER NERVA

Abstract

The NERVA small orbital launcher under development is based on the adoption of the three parallel and planar boosters for the first stage. The booster solid propellant rocket engines (SRE) are derived from the originating SA-2 missile design, otherwise largely transformed. Due to the very high thrust enhancement achieved by the first stage, which ends in unusually high levels of loading during the lift-off of more than 40 g-s, this conceptual solution proves quite challenging. The main challenge identified is connected with the possible uneven pressure, thrust and burn duration of the three SRE-s of the first stage, mainly of the two lateral ones. Experimental data show variations of up to 0.4 seconds in the duration of the powered phase for this type of SRE-s from a total of 3.4 seconds of burn and up to 1 percent variation in the total specific impulse of the engines, at a given and same temperature. Yet undetermined variations in the total ignition delay between individual motors are an even larger concern. While for the unique booster of the standard SA-2 vehicle the ignition delay has no relevance, when those engines are forced to work simultaneously the individual differences become catastrophic. This scatter in performance may induce severe imbalance between the two lateral engines, ending in a potentially severe damage of the launching rail, possible loss of flight stability along the boost phase and damage of the second stage structure. Due to the small size and imposed cost of the NERVA launcher, with a total lift-off mass of below 6000 kg, no means of thrust vectorization can be provided for the first stage and the entire challenge was solved through mechanical design solutions. They involve hot duct communication between the lateral thrust chambers, nozzle tilt angle, first motion retainer and first of all the staging mechanism between the first and the second stage of the launcher. Solutions are presented and the background design criteria involved. Acknowledgement is made that the project is led by University "Politehnica" of Bucharest, sponsored by the national Ministry of Education, Research and Innovation under the contract CNMP-82076-2008 and is subjected to an international cooperation with Texas A&M University. There is no connection between the NERVA-Near Earth Exit and Reentry Vehicle Assessor and the old, nuclear bomb propulsion system with the same acronym.