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IMPACT OF THE LUNAR GATEWAY LOCATION ON THE HUMAN LANDING SYSTEM IN CASE OF PERMANENT BASE AT THE LUNAR SOUTH POLE

Abstract

NASA's Gateway platform will be a critical element in enabling long duration crewed missions on the Moon. The deep space station location will define the trajectories for transfers between the Earth and the Moon and thus affect the lunar transportation architecture. One of the most affected systems will be the human landing system (HLS), whose main function is to deliver the crew from the Gateway to the lunar surface and back.

This paper discusses the impact of the Gateway location on the HLS elements sizing. In total, 12 Gateway orbits are considered, including polar circular and elliptic lunar orbits of different sizes, near rectilinear halo orbits (NRHOs) of L1 and L2 type, and an L1 conventional halo orbit. As the issue at hand involves crewed missions, the effect of potential abort operations (which differ for different Gateway orbits) on the resultant element sizing is also included in the analysis. NASA's architecture, which includes Descent, Ascent, and Transfer Vehicle Elements, is adopted for the HLS. Rocket equation and mass estimating relationships are used to size the HLS elements for different Gateway orbits.

Our analysis has revealed that all three elements are affected by the Gateway location. NRHOs, which are NASA's current baseline option for the Gateway location, are among the orbits with higher wet mass of all HLS elements. The lightest HLS corresponds to the Gateway in a 100-km polar circular orbit. In this case, the Transfer Vehicle is not needed at all while the Descent and Ascent Elements are 8% and 18% lighter respectively than their NRHO counterparts. This increase in the HLS mass along with more restrictive abort operations is a drawback to the benefits that a Gateway in NRHO can potentially provide.