19TH IAA SYMPOSIUM ON HUMAN EXPLORATION OF THE SOLAR SYSTEM (A5)
Human Exploration of the Moon and Cislunar Space (1)

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LUNAR PROVING GROUND LOGISTICS RESUPPLY – PERFORMANCE CONSIDERATIONS

Abstract

With the NASA exploration architectures revealing longer duration human missions over time, logistics resupply becomes a Key Driving Requirement (KDR) in the mission design and operational concept development. Today, an opportunity exists to extend current Low Earth Orbit (LEO) launch and cargo vehicle technologies to lunar vicinity applications. A revolutionary leap took place with the partnering investments between government and industry with the International Space Station (ISS) cargo resupply development and successful execution; and now the commercial crew transportation for the ISS. Similar investments and partnerships may well continue to lunar space exploration. Understanding the integrated performance of these potential cargo vehicles within the context of exploration mission designs to and within the Lunar Proving Ground is critical to the success of the early exploration missions. The authors tackle this question of integrated performance by taking the performance of current and future launch vehicle capabilities, representative Orion performance baseline and the recent studies of extended duration missions with a habitat, and providing an integrated analysis of various commercial-based resupply architectures. Based upon publically available information, ascent performance to trans-lunar injection analyses were performed and are reviewed in the paper regarding these launch vehicles' support to deliver currently available cargo vehicles such as the H-II Transfer Vehicle (HTV), the Dragon, and the Cygnus vehicle. The current configurations of the cargo vehicles are investigated with regards to the ability to support requisite cargo re-supply to the lunar Near-Rectilinear Orbit (NRO). Specifically, the launch vehicle and cargo vehicle performance gaps are investigated and reported on in the paper, providing stakeholders with the opportunity to discuss various options for closing the performance gaps and finding solutions which allow for successful logistics re-supply to the lunar NRO habitation spacecraft. Given the successful re-supply of ISS over the years, the potential for commercial cargo resupply to follow this same path into the Lunar Proving Ground is enormous. This paper aims to initiate the dialogue with regards to launch vehicle and cargo vehicle performance by presenting gap analyses and whether current vehicles offer an opportunity to be extended to the lunar vicinity. Some of the vehicles will be well suited to extending operations from Low Earth Orbit (LEO) to the lunar NRO, others may be less likely to be able to accomplish that transition.