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LUNAR BASE DESIGN INFORMED BY REGOLITH IMPINGEMENT MITIGATION

Abstract

It is becoming increasingly likely that humankind will soon venture back to the moon, “this time to stay”. Implied in that statement, and explicitly stated by multiple senior government officials from around the world, is the construction of a long-term or permanent human-rated purpose-built lunar facility requiring the aggregation of multiple pieces of interconnected infrastructure. Whether this infrastructure is previously emplaced solar-power generation units, ascent stages, supplies, habitats, or rovers, challenges not faced by the Apollo missions will be immediately evident. Of chief concern is the damage caused by lunar regolith accelerated horizontally across a wide area at high velocity by the descent engines of lunar landers. Investigations of recovered portions of the Surveyor 3 lander indicated that its exposed components were “scratched and pitted” by regolith accelerated by the descent engine of Apollo 12, which landed approximately 200 meters away. Analysis showed that some of the material reached speeds of 2 KM/S and traveled a significant distance. When performing single location single lander sortie missions (as in Apollo), this effect can be ignored; however, if the mission architecture requires the aggregation of supporting infrastructure around a permanent base located at the lunar south pole, such as in the later stages of the Artemis program or any attempt by commercial industry to develop in-situ resource utilization operations, this challenge becomes much more impactful. Essentially, civil engineering activities coupled with intelligent base design will be required to mitigate the negative effects of high-velocity regolith impact on surrounding base infrastructure before the second piece of infrastructure arrives. Should it be envisioned that the base will continue to grow for some time, optimal mitigation solutions should be incorporated in early planning efforts to minimize costly repositioning of individual base components in later development stages. This paper will examine the impact, with specific regard to base layout, these considerations would have on a permanent, and growing, human-rated facility located at the lunar south pole. The study will aim to model regolith effects across a lunar facility, considering both reasonable early-stage civil engineering mitigation actions and ascent/descent pad location. The goal of the project will be to draw generalized conclusions regarding optimal base layout useful to any lunar surface infrastructure planner.