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## The importance of lunar dust mitigation during future human led lunar missions

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With the Artemis mission set to launch in 2024, returning humans to the lunar surface for the first time in over half a century, it is imperative to ensure human health and safety on a variety of fronts. Lunar dust exposure is one of many areas of concern regarding astronaut health and safety. During the Apollo missions it was reported that lunar dust was a nuisance and induced allergic-like symptoms upon exposure. In addition, it was also reported that instruments became coated with dust that was difficult to remove, and that the dust adhered to everything and tore through space suit fabric. Numerous inhalation studies have determined that lunar dust is more toxic than analogous terrestrial materials but less so than silica dust. Apollo dust mitigation systems were successful on some missions but failed on others. As humans are to stay on the lunar surface for extended periods relative to the Apollo missions, it is vital to fabricate instruments that would address the lunar dust problem with greater reliability. There must be multiple steps to remove all lunar dust, including the ultra-fine  $<10\ \mu\text{m}$  fraction which was the most difficult dust size to remove. There must be multiple steps regarding lunar dust removal including a chamber to remove dust and de-suit, and a vacuum with high level HEPA filtration to remove dust. The first chamber would be to filter out any dust that comes into the module from the outside. Once all the air is clear, then the next step would be to remove any remaining dust on the suits using a hand-held vacuum with a HEPA H14 filter which only allows up to a maximum 0.005% of particles 100 nm in size to pass through the filter. Then, it would be safe to de-suit. It would be wise to have a second chamber between the first chamber and the command center of the lunar module that would vacuum any remaining dust before opening to the main command chamber. Ultra-high quality HEPA filters of both the chamber and hand-held vacuum systems should be replaced frequently to maintain optimal dust mitigation. Investing time and resources into lunar dust mitigation should be a top priority for the upcoming Artemis mission to avoid the issues encountered on the Apollo missions.