Dust Solution Testing Initiative (DuSTI): Infusing Commercial Off the Shelf Dust Mitigation Technologies with NASA Practices. A. H. Garcia[1], S. R. Deitrick[1], K. K. John[2], A. Cassady[2], A. S. Hobbs[2], [1]Jacobs Technology, NASA Johnson Space Center, Houston TX 77058, [2]NASA Johnson Space Center. (angela.h.garcia@nasa.gov ; kristen.k.john@nasa.gov)

Introduction: Dust is one of the most significant hazards to human lunar exploration. However, since the Apollo program concluded, limited research has been performed on lunar dust mitigation technologies. The safety of the crew members and sustainability of habitats, science, and supporting hardware depend on effective dust mitigation techniques and technologies. As NASA pursues a new generation of lunar missions with the Artemis program, the project team will pursue dust mitigation solutions with the Dust Solution Testing Initiative (DuSTI). DuSTI is a lunar dust mitigation effort that involves performing tests on commercial off the shelf (COTS) technologies over FY21.

DuSTI will preform component and subsystem tests in dusty environments for up to five technologies with high potential. The specific technologies identified for study were selected based on several factors, including a market analysis of current terrestrial dust mitigation applications, availability of the technology, accessibility of various testing facilities, and cost of procurement. These technologies support the active and passive dust mitigation requirements of filtration systems, electro-mechanical systems, electro-static systems, surface coatings, textiles, and silicone polymers. Technology Readiness Level (TRL) will be increased by validating components in relevant environments. For example, if the COTS technology is at a TRL 9 for terrestrial use but at a 4-5 TRL for use in the lunar environment, we will test that technology in a lunar dust environment to increase the TRL for use on the Moon.

Technology Gap: The current need for NASA to have effective dust mitigation technologies stems from its human exploration mission plan to return to the lunar surface in 2024 with continued surface missions throughout 2030, including permanent habitation in the next 10 years. NASA's official lunar dust mitigation strategy will implement a three-pronged approach: operational and architecture considerations, passive technologies, and active technologies [1]. DuSTI will contribute to all three components.

Gap 1: Commercial Availability. With the return to the lunar surface being announced recently, the need for dust mitigation techniques has increased, but the availability of dust mitigation technologies for reduced gravity and micro-atmospheric environments is still limited due to the lack of lunar missions after the Apollo Program terminated in 1972. Without the demand, the focus for dust mitigation became limited to consumer appliances, construction and military aircraft landings in desert environments. Successful testing of commercially available dust mitigation methods in a simulated lunar environment alleviates the challenges associated with research, testing, production, and application of these methods. This allows NASA engineers to focus specifically on testing and application which preserves resources like funding, labor and time for developing aspects of the 2024 lunar mission.

Gap 2: Uniqueness of Environment. Most commercial companies providing dust mitigation technologies test their products based on the environments and particulates encountered on Earth. Testing of these COTS technologies in a simulated lunar mission environment must be conducted to determine if they can support the changes in pressure, temperature, and solar radiation both inside the pressurized vehicle, EVA suit or habitat, and outside of the vehicle, on the lunar surface or in orbit. It is also vital to test with the dust/regolith simulant particulates that have been created to replicate the aspects of the lunar regolith needed for testing.

Future Work: The results of DuSTI testing will be compiled into a technology infusion report in Q4 of FY21 and each year the project is funded. These technologies will be tested using NASA JSC/KSC/GRC and Air Dynamics test facilities designed to simulate the lunar environments that are expected during the upcoming Artemis missions. DuSTI is aligned to improve upon modern methods of lunar dust mitigation in a variety of lunar surface mission environments,setting the stage for astronauts to address dust mitigation challenges for sustained lunar presence.

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References: [1] Johansen M. R. (2020) *Lunar Dust Workshop, No. 2141.*