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CHARACTERIZATION OF ORGANIC CONTAMINATION FOOTPRINT FROM MOON, MARS AND OCEAN WORLD LANDING SYSTEMS FOR ROBOTIC AND CREWED MISSIONS

Abstract

The Office of Planetary Protection and technical community establishes protocols for missions to solar system bodies to ensure they are not harmfully contaminated for scientific purposes by biological and organic contamination of Earth origin, and also to protect Earth from potential harmful biological contamination from returned missions. The landscape for Planetary Protection is evolving at a fast pace with missions of both commercial and scientific interest to bodies in our solar system. Planetary science and planetary protection techniques have been evolving rapidly in recent years, and Planetary Protection guidelines and practices will likely be updated to reflect the rapidly evolving state-of-the-art and new technologies, and the emergence of commercial and scientific missions across the solar system. This paper addresses the principal organic contamination vectors for several classes of landing systems: materials outgassing, thruster plumes, vacuum venting and leakage. The landing system classifications selected for exploration range from small orbiters (SmallSats and CubeSats) and small landers (i.e., NASA Commercial Lunar Payload Services landers) to large landers such as the concepts proposed by Human Landing Systems (HLS) providers. A new vision for a comprehensive organic inventory is presented. The initial study leverages existing experience in conjunction with modeling and analysis capabilities to characterize the relative contributions for each organic contamination vector. The results will be jointly reviewed by the Planetary Protection, Science and Contamination Control technical communities and can support the evolution of the current framework for organic contamination inventory and archive protocols. The characterization of the organic contamination vectors leverages multi-species materials outgassing testing and modeling, recent results from thruster plume induced contamination testing of monopropellants and bipropellant thrusters, and operational experience with vacuum venting from the crewed systems (Space Shuttle and International Space Station).