Robotic and Crewed Mars Missions Increasing the Demand for Planetary Protection Technology Needs

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Planetary protection (PP) policy seeks to avoid harmful contamination by limiting biological and relevant organic contamination from spacecraft as well as preventing adverse changes to Earth's biosphere when extraterrestial samples are brought back to Earth. The PP policy at NASA was updated in 2021 (NPR 8715.24) and 2022 (NASA-STD-8719.27) to enable missions by expanding the decades old prescriptive requirements to allow for an option of adopting performance-based requirements that are objectives-driven, risk-informed and case-assured. In parallel, the final PP knowledge gap workshop was completed representing the international consensus on the key areas to be considered in developing crew PP policy. These knowledge gaps focused on key technology development areas in 1) microbial and human health monitoring, 2) technical and operations needed for contamination control and 3) natural transport of contamination on Mars. As robotic missions start to implement performance-based approaches and research and technology efforts commence to inform crew policy the demand for data quality driven verification and validation in relevant space environments. Examples of the types of testing that is envisioned includes test as you fly validation and verification of decontamination systems in a relevant on-orbit and Mars environment, developing lethality curves of terrestrial organisms to further our understanding of the biocidal impacts of Mars and the space environment, and particle transport model validation and verification. Thus, the PP discipline has identified the need for ground-based space environments to perform preliminary testing as validation and verification of flight systems and to advance the technology readiness level prior to further testing on-orbit or lunar environments to prepare for Mars.