Survival of Spacecraft Associated Microbes Under Simulated Martian Solar Constant

David A. Newcombe[1], Andrew Schuerger[2], James N. Benardini[1], Jeff Richards[3], and Kasthuri Venkateswaran[1]

[1]Biotechnology and Planetary Protection Group, Jet Propulsion Laboratory, California Institute of Technology; [2]University of Florida, Space Life Sciences Lab, Kennedy Space Center, FL; [3]Dynamac Corp., Kennedy Space Center, FL

Terrestrial microorganisms recovered from spacecraft surfaces and assembly facilities were exposed to radiation at the Mars simulated solar constant (MSSC). The effects of UVA, UVA+B, and the total MSSC radiation on the survival of microorganisms were studied under Earth as well as Mars atmospheric conditions. Investigation of these different wavelengths is important because dust suspended in the Martian atmosphere can strongly attenuate UVC while allowing both UVA and UVB to reach the surface. Selected microbial species isolated from several spacecraft (Mars Pathfinder, Mars Odyssey, Genesis, X-2000 [avionics], and International Space Station) and their assembly facilities (Jet Propulsion Laboratory, Kennedy Space Center, and Manassas, VA). Purified spores of several *Bacillus* species were initially screened for their resistance to UVC irradiation (254 nm) using a low-pressure mercury lamp. Separate UV bands at the MSSC including UVA (315 – 400 nm), UVA+B (280 – 400 nm), and full spectrum (200 – 400 nm) irradiation were created by placing several filters in the light path of the xenon-arc lamps. Results showed that spore-forming bacteria isolated from spacecraft surfaces were more resistant than a laboratory strain, *B. subtilis* 168. Among ten *Bacillus* species tested, *B. pumilus* SAFR-032 showed highest resistance to all three UV bandwidths. LD_{90} of *B. pumilus* SAFR-032 under MSSC is 300 sec., about 10 times greater than *B. subtilis* 168. In Mars chamber simulations (MSC), including appropriate pressure and atmospheric conditions without UV irradiation, the effects of Martian pressure were found to have only a minor effect on the viability of several *Bacillus* species. However, with exposure to MSC-UV irradiation only, the survival rates of the *Bacillus* species suggests that most sun-exposed surfaces on spacecraft will be sterilized within a few hours on the first Sol after landing under clear-sky conditions. Results of this work will help to refine the Planetary Protection programs for future near-term Mars lander, rover, and orbiter missions.