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ELECTRICAL SYSTEM/ENVIRONMENT INTERACTIONS ON THE PLANET MARS *J.C. Kolecki, G.B. Hillard, and D.C. Ferguson, Space Environment Interactions Br., NASA Lewis Research Center, NASA 2100 Brookpark Road, Cleveland, OH 44135*

The Martian environment is a diverse environment with which systems will interact in numerous ways. The following comments are preliminary thoughts on electrical system/environment interactions which might be of interest to system designers at all stages of system design.

Stationary surface sand and dust may be subject to electrical charging due to incident solar ultraviolet light which reaches the Martian surface at an intensity approximately equal to its value in Mars space. Additionally, sand and dust charging could also occur around electrically powered systems by induced dipole coupling effects with exposed high voltage surfaces. When such charging occurs, regardless of the mechanism involved, Coulombic forces result in the sand and dust being attracted and adhering to surfaces, thereby modifying surface thermal, optical, and dielectric properties. Stationary surfaces will acquire variable coatings of sand and dust which must be dealt with both in system design, and later, in situ on the Martian surface. Further, sand and dust transported on roving vehicles, and/or human explorers moving out of and into controlled volumes could pose a significant contamination problem.

Wind borne dust may also be subject to electrical charging due to triboelectric mechanisms. Differential settling of triboelectrically charged dust following major dust storms may result in significant charge seperation with concomitant electrical breakdowns between surfaces, or to the Martian ground or atmosphere. Additionally, the presence of variable levels of sand and dust in the Martian atmosphere may significantly modify atmospheric electrical properties as seen by systems on the Martian surface. As a gas, the 7 - 9 Torr surface atmosphere is ideal for Paschen electrical breakdown over mm to cm distances at a few hundred volts, and cm to m distances at a few kilovolts. Atmospheric dust will certainly modify the breakdown properties of the atmosphere, acting possibly to seed or suppress breakdown phenomena around high voltage surfaces depending on such factors as atmospheric dust concentration, dust surface adhesion (or lack thereof), and dust dielectric properties. Paschen breakdown phenomena have been observed on Earth in simulated Martian conditions, and are known to result in system power loss and electromagnetic noise. Transient and sustained electrical discharges in general may sputter erode surfaces and result in contamination due to transport and redeposition of material.

The question which is of most interest here is: What happens when you add a system to an environment and "shake well?" How does one characterize the resulting interaction and use that knowledge to produce optimal system designs? Some areas for consideration/development include:

1.) Identifying relevant physical mechanisms/equations
2.) Producing, and (where necessary) experimentally verifying mathematical models
3.) Understanding user needs and establishing appropriate user interfaces
4.) Establishing appropriate input/output formats
5.) Identifying/performing relevant laboratory/space tests and analyses
6.) Delivering user-friendly software with appropriate interfaces

The Space Environment Effects Branch has worked for almost two decades on the development of analysis tools and computer software for use in designing systems for the LEO and GEO plasma environments. This software includes NASCAP/LEO and NASCAP/GEO (NASCAP = NASA Charging Analysis Program), which model system-plasma interactions including spacecraft charging, arcs and transient phenomena, anomalous switching, spacecraft grounding effects, and numerous related issues. Other software packages (EPSAT, and SSF ENVIRONMENT WORKBENCH) are also under development which will provide frameworks into which specific environment and system models may inserted, and interactions predicted. The charter of the Space Environment Effects Branch is to develop and provide modeling and analysis tools for the interactions between given environments and given systems, and to conduct whatever experimental and/or flight activities are necessary to validate those tools. With the advent of the Space Exploration Initiative, it seems appropriate that interactions models be developed for the moon and Mars. These models will provide systems engineers with unique, user-friendly tools which will couple the environmental models currently under development with systems models either extant or yet to be developed, and to predict the interplay of the two from an electrical/plasma interactions point of view. This capability will enable the best possible use of the environmental models for the moon and Mars in the production of optimal system designs.