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RE-USE OF EXOMARS ROVER ON ICY MOONS OF JUPITER

Abstract

The ExoMars Rover, developed by EADS Astrium to perform in-situ investigations into the potential existence of life on Mars, may also be exploited for use on other planetary bodies. The Icy Moons of Jupiter (JIMs): Europa, Ganymede and Callisto, are in particular also of key interest to astrobiologists and geologists. The purpose of this research was to perform a feasibility analysis on the operation of the ExoMars rover on these icy moons. Specifically, this involved a design/concept study to determine whether such a mission is possible with the current rover design, from a thermal and system power point of view, and, if not, what modifications would need to be implemented for successful operation. The European Space Agency standard software tool ESATAN-TMS was employed to perform a detailed thermal analysis. Initially the original, simplified Exomars thermal model, as provided by EADS Astrium-UK, was simulated in the extreme environment of Jupiter's icy moons. From the findings, it was determined that alterations were necessary to the passive thermal control and power sub-systems. The rover model was updated and then again placed in the icy moon environments. Five scenarios were analysed, encompassing the equatorial and polar regions of both Europa and Ganymede and the equator of Callisto. The results of these missions were post-processed in the advanced post-processing tool ThermNV. It was found that major design changes were required, as the original rover was completely unable to maintain its required internal temperature range on JIMs. Key changes implemented were the reduction of radiator areas, and replacement of solar arrays with Multi Mission Radioisotope Thermoelectric Generators and their accessories. The external structural temperature was also found to become too low when on the moon's surface and a redesign of this element is recommended; however, altering the structural design was beyond the scope of this research. From the analysis of all defined scenarios, it was concluded that the rover need major changes in structure, power subsystem and slight changes in radiators sizing. Of key significance, however, was the finding that if the modified rover is made suitable for one moon, then it would be able to operate in the environments of all three icy moons. Consequently, it is feasible that following these design changes the ExoMars rover concept could be employed for the exploration of JIMs, which would have significant scientific value over a range of science missions, search for life and other geological investigations.