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STATISTICAL RELIABILITY ANALYSIS OF INTERPLANETARY SPACECRAFT OPERATING AT DIFFERENT INTERPLANETARY EXTREMITY

Abstract

Reliability of the spacecraft determines the extent of success probability and mission accomplishment. Despite effective testing and integration, the complexity of the space environment affects reliability. In this paper, we investigate the reliability behaviour of interplanetary spacecraft operating at different interplanetary extremities. So, our investigation assesses spacecraft inhered in interplanetary space with the context of the interplanetary boundary (between distinct planetary orbit or within the bounds of heliopause). From the perspective of spacecraft reliability in interplanetary space, we have excluded planetary landers, atmospheric probes, and satellites maneuvering earth orbit. Thus, we have identified 131 spacecraft (includes 82 probes within the bounds of Sun and the Earth, and 49 within the bounds of Earth and Heliopause) along with their gross mass at launch and lifespan. Based on acquired data, we first conduct a non-parametric analysis of spacecraft reliability to obtain two reliability curves for distinct interplanetary extremity. We then perform a parametric fit (Weibull Distribution) over the data to show the analogy of reliability behaviour. Results showed that the spacecraft operating beyond the extremity of the Earth and the Mars exhibits increased reliability than any other interplanetary extremity. In addition to this, we execute reliability analysis over spacecraft of various mass categories (Small-Medium-Large) to testify the reliability effect interpreted by Dubos in 2010. Finally, we discuss the possible factors and causes accountable for the difference in reliability behaviour concerning the spacecraft design and integration, testing, and constraints in considering spacecraft mass.