PRE-FLIGHT SPECIFICATION AND IN-FLIGHT MONITORING OF RADIATION HAZARDS FOR ELECTRIC ORBIT RAISING MISSIONS

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ABSTRACT

Low-thrust propulsion methods to raise perigee from geostationary transfer orbit necessarily raise questions about the impacts to the vehicle from the additional time spent at lower altitudes and in more intense trapped radiation environments. These methods yield longer residence times within the inner proton belt and the more intense portions of the outer electron belt than with conventional chemical propulsion. One effect is more scrutiny of the total system design margin for total dose, vehicle charging, and single event effects because of the interest in minimizing changes to the baseline geostationary satellite design. Another complication is how to specify worst-case charging and single-event effect environments when both the orbit and environment are known to change with time.

In the paper we will discuss practical approaches for specification of the charging, single-event effect, and total dose environments for missions using low-thrust perigee raising methods. These involve the AP9/AE9 models and probabilistic models for solar particle events. We will present examples of analyses for several orbit-raising scenarios in order to compare the hazards during transfer with typical 15-year geostationary specifications.

We will also discuss low-impact sensors that one can use to monitor the relevant hazards during the electric propulsion phase and once final orbit is reached. Monitoring the actual observed hazards and their effects is critical for assessing the effectiveness of any design changes for the low-thrust portion of the mission. As experience grows with more vehicles raising perigee in this way, the hazard measurements will also inform the confidence intervals applied to the AP9/AE9 and solar particle models in lieu of arbitrary radiation design margins.