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AN UPDATE ON THE EFFECTIVENESS OF POSTMISSION DISPOSAL IN LEO

Abstract

The commonly-adopted orbital debris mitigation measures were developed to reduce the growth of the future debris population. A major component in debris mitigation is postmission disposal (PMD). The key PMD element for LEO satellites is the 25-year rule, which is intended to limit the long-term presence of rocket bodies (R/Bs) and spacecraft (S/C), as well as mission-related debris, in the environment. The effectiveness of PMD has been demonstrated and documented since the development of mitigation measures began in the 1990s. This paper summarizes an updated study, based on the current environment, using the NASA LEGEND model.

The study focused on the 10 cm and larger population in LEO. The historical simulation covered 1957 through 2011 and followed the recorded launches and known breakup events. The future projection was carried out for 200 years. An 8-year launch traffic, from 2004 through 2011, was repeated during the projection period and an 8-year mission lifetime was assumed for future S/C. No stationkeeping and no collision avoidance maneuver were implemented. Only objects 10 cm and larger were included in collision consideration and no explosion was allowed for R/Bs and S/C launched after 2011. The 25-year PMD rule success rates were set at 0%, 10%, 50%, 75%, and 95%, respectively, for the five study scenarios.

Results of the simulations were analyzed to quantify the differences among the different compliance rates. As expected, the 0% PMD projection followed a rapid and non-linear increase in the next 200 years. The LEO population, on average, more than tripled at the end of the simulations. The increase was driven by approximately 70 catastrophic collisions. For the 50% compliance scenario, the population increase was reduced to about 150% in 200 years. However, even with a 95% compliance of the 25-year rule, the LEO debris population still would increase by an average of more than 50% in 200 years, as a result of approximately 26 catastrophic collisions. These simulation results provide an updated assessment of the effectiveness of the 25 year rule. It is the first and the most cost-effective defense against future population growth. In addition, the results also confirm the instability of the LEO population and lay the foundation for the need to consider environment remediation in the future.