CHARGING AND DISCHARGING RISK EVALUATION IN MEO ELLIPTIC ORBIT BASED ON SPACE ENERGY SPECTRAL CALCULATION

Xuesong Zhen\(^{(1)}\), Hao Wang\(^{(2)}\), Yiyong Wu\(^{(2)}\), Chengyue Sun\(^{(2)}\), Dandan Ju\(^{(2)}\), Yanqing Zhang\(^{(2)}\), Guoliang Ma\(^{(2)}\)

\(^{(1)}\) School of Material Science and Engineering, Harbin institute of technology, No.92 West Dazhi Street, Nangang, Harbin, China, zhengxuesongkx@163.com
\(^{(2)}\) Laboratory for Space Environment and Physical Sciences, Harbin institute of technology, No.92 West Dazhi Street, Nangang, Harbin, China, wuyiyong@hit.edu.cn

ABSTRACT

Medium Earth Orbit (MEO) is the region of space around above low earth orbit 2000 km to below geostationary orbit 35786 km. In this region, satellites involving with the scientific research, navigation and communication, would face the complex space environment especially as sophisticated energetic charged particles environment. During cruising along a MEO elliptic orbit, satellite would encounter into inner and outer Van Allen radiation belt from the whole orbit altitude. The variation of radiation energy and flux along the orbit changes dramatically according to the space energy spectral calculation. And these fluctuations will affect charging and discharging behavior of insulator material in two ways, one is flux related charging and discharging breakdown in a relative high surface potential and another is radiation energy related radiation induced conductivity (RIC) change to alter insulator into conductor causing discharging between potential difference sites. In this paper, we evaluated the spectral energy distribution (SED) of a MEO elliptic orbit with perigee of 800 km, apogee of 35786 km and inclination of 56 degree. Particle energy from 40 keV to 10 MeV was calculated along the orbit and the instantaneous and integrated energy spectral showed that abrupt changes of electron energy and flux were potential threats for discharging of PI. By applying the power law of RIC varying with electron irradiation time and irradiation does rate, the conductivity change of PI was calculated and revealed less importance of electron energy in change PI conductivity to cause sudden discharge. The flux along orbit was also examined to exhibit the danger region for discharging, calculation showed that during approaching to earth flux of 200 keV and 2 MeV electron changes 4 to 6 order of magnitude, which means a great difference in surface charges accumulation and results in a great risk of discharging. Although the RIC in a single cycle has less effect on discharge, the long term service of satellites with irradiation defects accumulation would eventually affect the PI conductivity and rise the risk of discharging. The main routine of this paper could draft the guideline for the evaluation of charging and discharging behavior in the sequence of orbit energy spectral calculation, RIC and flux related charging discharging evaluation and interesting/critical environment condition ground-simulation.