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RELIABILITY GROWTH OF A NANO-SATELLITE THROUGH TESTING

Abstract

There is increasing demand of nano satellite development worldwide. Its advantages are low-cost and fast-delivery. Its success rate is, however, much lower than traditional satellites. The satellite reliability can be modelled by Weibull statistics. A satellite goes through a series of tests. The tests may detect various defects in design, material, workmanship, etc. Once a defect is detected, it is corrected and the test resumes or the development process goes back to an earlier phase. The failure rate keeps decreasing as the testing continues until it becomes a steady value indicating the shift to the random failure mode. Although the idea of reliability growth is understood from our experience, quantitative data taken from a real satellite project is scarce. There is none for nano-satellites where little documentation is done.

The purpose of the present paper is to demonstrate how the reliability is improved by testing based on the real data taken during the test campaign of a nanosatellite. Currently, we are developing a 10kg nanosatellite, HORYU-IV, to be launched in 2015. Its testing process is recorded extensively to keep the time log of finding latent defects. We draw the reliability growth curve by plotting the cumulative number of defects found during the testing against the total testing time or testing items. From the curve, we extract how the defect rate changes as the test progresses.

We discuss the testing strategy to optimize the cost (or schedule) against the reliability. In 2014 IAC, the Monte Carlo simulation results of the reliability growth were presented. In the simulation, an initial failure rate made of a time-dependent part according to a Weibull distribution and a constant part were assumed a priori. At each phase of testing, whether a defect is detected or not was judged by a random number for each sub-system. If the defect was detected, either the same test phase was repeated or the test phase went back to the previous stage, but both with the reduced failure rate. The overall test time was calculated and compared to the final reliability that depends on how many of latent defect remained undetected. We apply the time varying defect rate extracted from the HORYU-IV test campaign as an input parameter of the Monte Carlo Simulation. The simulation results are revised based on more realistic defect rates.