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EVALUATION OF THE EFFECTIVENESS OF 5-YEAR RULE – IMPACT ON THE ORBITAL ENVIRONMENT AT EACH ALTITUDE BY REDUCING THE POST-MISSION DISPOSAL LIFETIME

Abstract

This paper examines the effect of shortening the post-mission disposal lifetime, i.e., changing the so-called 25-year rule to 5-year rule. Using NEODEEM, debris evolutionary model developed by Kyushu University and JAXA, we evaluated the change in the on-orbit environment at each altitude in terms of long-term stability and short-term safety such as the number of collision avoidance maneuvers and the collision rate. When evaluated in terms of the long-term total effective number of on-orbit objects, the 25-year rule is sufficiently effective and has been adopted in consideration of the balance with the V required for orbit transfer. However, it is not appropriate to evaluate only by the effective number of objects. For example, the greater the effective number in the low orbit in the initial state, the fewer the overall number appears to increase due to the cancellation of the effect of their decay from the lower altitude and their tendency to increase at high altitude, but in reality, the situation is different at each altitude. Thus, it is necessary to evaluate not only the effective number of objects but also the collision rate, etc. at each altitude in order to assess long-term stability. In addition, if the number of launches increases beyond what has been assumed, it would be necessary to evaluate its impact. It is shown the collision rate at an altitude of around 600 km will increase if the number of launches to high altitude and the PMD compliance rate increases, although the impact of collision is not long term. In the short term, the 5-year rule reduces the collision rate and collision avoidance frequency at an altitude around 600 km more than the 25-year rule. Similarly, if the number of spacecraft descending to an altitude of around 500 km increases due to the 5-year rule, the collision rate and the expected number of collision avoidance maneuvers for the ISS, for example, will increase in the very short term. However, if the 5-year rule is not applied instead of the 25-year rule, and subsequent collisions occur at altitudes around 600 km, the collision rate and expected number of collision avoidance maneuvers will increase later because the fragments fall to a lower altitude. This suggests that the post mission disposal lifetime should be set according to the number and size of objects launched.